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This report describes design techniques, areas of effective application, and research directions in educational simulations. The five chapters contain (1) a review of recent literature; (2) an overview of the field of simulation including definitions and some of the rationales for using simulation in instruction; (3) an outline of the design approaches of several major simulation centers and a model containing 13 specific guidelines for use in designing an instructional simulation system; (4) an analysis of the implications for education of simulation applications in the military, government, and industry; (5) examples of the application of simulation to several areas of vocational education; and (6) illustrations of the use of simulation as a measurement device for assessing educational progress and predicting complex human behavior. The appendix contains a list of some common independent and dependent variables in simulation games, four issues of the Instructional Simulation Newsletter, and a list of 11 suggested new directions for games and simulations. (JH)

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INSTRUCTIONAL SIMULATION: A RESEARCH DEVELOPMENT AND DISSEMINATION ACTIVITY

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Preface

This report represents the culmination of 18 months of work. It seeks to present in a systematic fashion many ideas not previously discussed in any formal way. Perhaps the reader should be cautioned on two counts. First, the report does not represent all that is known and thought about simulation. To review and incorporate in the report all of the more than 1500 articles and studies on file at Teaching Research was beyond the scope of the project. Yet, an attempt was made to bring to light much of the lesser known and relevant information that might escape notice. Second, the report should not be taken as the last word on simulation. Much that could be written on simulation remains unwritten, and awaits the development of further empirical evidence and some mind-stretching thinking and reflection. If this document can help serve as a "benchmark" for further exploration, then the writers of this report may well feel proud of their efforts.

One person whose name does not appear in the list of authors deserves more than passing credit. Dr. Jack Gordon contributed much in way of insight and constructive criticism during the early phases of the project.

Paul A. Twelker
Director
Simulation Systems Program

Simulation is a means for letting learners experience things that otherwise might remain beyond their imagination, a means to practice skills safely and without embarrassment, and perhaps even discover insights into problems now plaguing mankind.

Summary

While there can be no serious doubt as to the relevance of simulation to education, there are crucial issues of concern:

Where is simulation best applied?

How can it be used most effectively?

How are simulation exercises designed?

What are important research directions in simulation?

The present report discloses the results of some 18 months of exploration into these and other issues.

The chapter, Simulation: An Overview (Paul A. Twelker), furnishes the reader with a broad look at the field of simulation, and provides a rationale and conceptual frame for subsequent discussions. It examines many of the more important issues in the design and use of simulation.

In The Design of Instructional Simulation Systems (Jack Crawford and Paul A. Twelker) the authors examine how several simulation centers around the country look at simulation design, and then present the approach taken at Teaching Research. A thirteen-step model of simulation design is described.

The chapter entitled Instructional Simulation: Past, Present, and Future (Paul A. Twelker), examines the application of simulation in school and non-school settings. Examined are some uses of simulation in the military, business, and government. Implications of these applications to civilian education are discussed.

Two other chapters concern themselves with research directions and application. In Simulation in Vocational Education (Dale G. Hamreus), important contributions of simulation from the military in vocational training are discussed in light of civilian occupational training. Second, special attention is given to the use of simulation for measurement purposes in Situational Response Testing: An Application of Simulation Principles to Measurement (H. Del Schalock).

Prologue

Simulation is a generic term that refers to a variety of instructional techniques at all levels of complexity. It has been applied in the military in over 3000 different forms. Examples of military application include aircraft simulators, huge weapon systems simulators that require teams of operators, and space simulators. It has appeared in the business and industrial world in over 150 different forms. Most of these applications take the form of management games.

Simulation has recently made its appearance in education. Simulation is currently used to train prospective teachers, business students, nurses, dentists, and students at all levels from kindergarten through college.

There is no serious doubt as to the relevance of simulation to education. The real issue is in identifying the range of activities to which it applies, and how it can be used most effectively. One investigator hints that simulation applies to the stimulus elements of instruction -- that is, the expositional aspects of instruction (Wallen, 1966). Another emphasizes its place in the response aspects of instruction. Gagne (1965), for example, seems to limit the application of simulation to the process of acquiring skill at a late stage of learning where "book knowledge" or "theory" is put into practical action. Still another writer focuses upon the role of simulation in applying "feedback" to the process of learning. Kersh (1963), in his initial work on classroom simulation places a great deal of emphasis upon feedback manipulated as "reinforcing stimuli." In his later work, this feedback was to be determined by the experimenter and was termed "controlled feedback."

While simulation has had wide application in disciplines such as the military and business, it has not as yet had an adequate trial in education. For example, vocational education has been slow to adopt training procedures using simulators that the military has used for some time. At this point in time, the educational world must look at instruction simulation as an interesting but difficult-to-use innovation.

While progress is being made in the application of simulation procedures to education, there are a host of problems that need to be resolved before we can really determine or assess its full impact in the educational arena. We have no clear idea of the nature or range of its application to education; we do not have available models of simulation design that might guide the developers as they specify what form and shape the simulation is to take, we have little idea of what type of simulation is most appropriate for the various types of learning that we might be interested in; we have little information as to the effectiveness of simulation techniques as compared with some alternative training procedures in bringing about educational objectives.

The stated objectives of this research development and dissemination effort were:

(1) To develop a comprehensive annotated bibliography of the literature pertaining to simulation use and design, including industrial and military sources;

(2) To develop guidelines for simulation design;

(3) To identify research directions in the area;

(4) To indicate curricular areas where instructional simulation techniques might be applied; and

(5) To disseminate the above information widely by means of films, demonstrations, institutes, workshops, and reports.

These objectives were not considered as limited only to the edification of Teaching Research. Rather, the products and information that would come out of the program were to be shared with educational researchers throughout the nation, and even internationally. Through dissemination activities, it was hoped that groups and individuals would be stimulated to develop instructional simulation experiences in their own area of interest.

It should be pointed out that the initial phases of the project involved cooperative efforts with the Northwest Regional Educational Laboratory. For example, an 848-item bibliography was prepared entitled Instructional Uses of Simulation: A Selected Bibliography. Although some 800 copies were published, sources were quickly depleted. Also, a film, "Of Men and Machines" and a supplementary guide were developed that reported the highlights of a series of four conferences held in the Pacific Northwest. These conferences invited leading experts on simulation and related areas to speak on their particular work and its relevance to education.

The introductory remarks that follow report the various activities of the project, and summarize its outcomes. Succeeding chapters deal extensively with issues in the area of simulation as raised in the statement of objectives.

Search of the Literature

This effort led to the publication of an annotated bibliography of approximately 1500 references: Instructional Simulation Systems: An Annotated Bibliography (P. A. Twelker [Ed.]). The search tapped both published and unpublished documents from civilian, military, and industrial sources. When a document described a simulation exercise or learning game in sufficient detail, a special format was used to indicate the subject, learner population, price, materials, and so forth. Approximately 300 simulation exercises and games were catalogued in this manner. It should be mentioned, however, that many of these exercises are not commercially available, and in many cases, only the briefest description of the particular simulation was provided in the original source.

Simulation Design Guidelines

Major activities associated with this objective entailed the examination of how several simulation centers around the nation view the business of simulation design. Interviewed were Mr. Richard Braby of the Naval Training Service Center, Mr. Lawrence Liss of the Nova Academic Games Project, Dr. Sarane Boocock of the University of Southern California (formerly from Johns Hopkins University), and Miss Alice Gordon and Mr. David Sakowinski, of Abt Associates, Inc. Concurrently, efforts involved the specification of guidelines from the staff's own experience in the area. Several things became obvious in this work. Extensive training programs would be required to teach individuals to become simulation designers. The communication of guidelines or flow charts at a level of detail necessary for individuals to function independently was beyond the scope of this project. To this end, Chapter II, *The Design of Instructional Simulation Systems*, presents only the major steps involved in simulation design. *The guidelines developed should be subjected to further empirical test and refinement*. The final product should then be used as a basis for developing extensive training manuals for various target audiences, i.e., elementary and secondary teachers, college personnel, educational researchers, and instructional media personnel.

Research Directions and Applications

The opening chapter, *Simulation: An Overview*, furnishes the reader with a broad look at the entire field of simulation, provides a conceptual frame for subsequent discussions, and examines many important issues in the design and use of simulation. In addition, important research directions are identified. A cursory examination of the literature revealed that *little relevant research is being conducted currently that is relevant to simulation design, use, or evaluation*. Most research has studied variables of tangential or questionable relevance, or has been conducted with such obvious limitations or faulty design that it is difficult to take the findings seriously. This is not to say that well conducted meaningful studies have been done, but these studies are few and far between.

In addition, the third chapter, *Instructional Simulation: Past, Present, and Future*, looks at the application of simulation in both non-school and school settings. Examined are some uses of simulation in the military, business, and government. Implications of these applications to civilian education are discussed.

Two other chapters concern themselves with research directions and application. In Chapter IV. Simulation in Vocational Education, important contributions of simulation from the military in vocational training are discussed in light of civilian occupational training. Finally, special attention was also given to the whole matter of using simulation for measurement purposes (see Chapter V. Situational Response Testing: An Application of Simulation Principles to Measurement. Many issues and research directions are indicated, and several examples of applications are discussed in this chapter.[1]

Dissemination Activities

National Institute. A four-week institute for university and college personnel in educational media was held during the summer of 1968 for 33 participants. The institute, entitled "Simulation in College Instruction" examined the many applications of simulation currently being used in both school and non-school settings. A major objective of the institute was to have the participants develop specifications for simulation in their own area of interest. Twenty-eight package specifications were produced in all, illustrating the highly successful nature of the institute.

Funds for another institute that builds on the previous one are being sought through the EDPA Act. This proposed institute in addition to offering another four-week institute, would offer a two-week institute for community college personnel as well as an eight-week trainer institute for eight returnees from the previous summer's institute. The trainees would receive advanced training, and intern in the two institutes that would be held concurrently.

Newsletter. Periodically during the project, four newsletters were released to acquaint researchers and educators with cogent findings uncovered during the information-processing activities, and other items of general interest (see Appendix B). Their major function was to make people aware of reports or ideas that were vital to the effort of developing simulation techniques. By the termination of the project, over 500 names were on the mailing list.

Workshops and Demonstrations. These activities were not limited to the Pacific Northwest. A partial list of groups for whom dissemination activities were conducted appear below:

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[1] Appendix C also lists other suggested new directions in simulation.

Oregon Compact Principals Conference,
   Bend, Oregon, June 4-5, 1968

Business Administration Seminar, Oregon State University
   Corvallis, Oregon, May 28, 1968

National Research Training Institute
   Traverse City, Michigan, August 29, 1968

Bureau of Indian Affairs Institute
   Monmouth, Oregon, June 20, 1968

Secondary Teachers Workshop
   The Dalles, Oregon, August 19, 1968

Social Studies Council Workshop, Benson High School
   Portland, Oregon, October 11, 1968

Elementary and Secondary Teachers Workshop, Tigard School District
   Tigard, Oregon, October 11, 1968

Washington Social Studies Council
   Longview, Washington, October 18, 1968

Keithley Junior High School
   Tacoma, Washington, October 17, 1968; January 10, 1969

Centennial School District
   Warminister, Pennsylvania, July 18-19, 1968

Salem Teachers Communication Committee
   Salem, Oregon, May 27, 1968

Adult Education Association
   Des Moines, Iowa, November 15-17, 1968

American Educational Research Association
   Los Angeles, California, February 6, 1969

Association for Supervision and Curriculum Development Conference,
   "Simulation: Stimulation for Learning."
   San Diego, California, April 24-27, 1968

Association for Supervision and Curriculum Development Conference,
   "Simulation: Stimulation for Learning."
   Boston, Massachusetts, October 24-27, 1968

John Marshall High School Teachers of the Disadvantaged Workshop
Portland, Oregon, July 18, 1968

Salem Public Schools Teachers Workshop
Monmouth, Oregon, October 19, 1968

Phi Delta Kappa Regional Meeting
Monmouth, Oregon, November 19, 1968

Phi Delta Kappa Regional Meeting
Corvallis, Oregon, January 21, 1969

U. S. History Inservice Teachers Project. As a direct result of the Oregon Compact Principals Conference in Bend, Oregon, 26 high schools throughout Oregon have provided funds for an inservice project that has as its main objectives: (1) the training of teachers of U. S. History to use existing simulations in that area, and (2) the cooperative development of new U. S. History simulation exercises and learning games. This project is tailor-made to test in a field trial the guidelines of simulation design reported in Chapter II. Supplementary funds are being requested from various sources for this program.

The rationale for the development of simulation games in U. S. History is simple. To the student sitting in the classroom faced with a checklist of 100 most important dates in U. S. History, a list of American Presidents, Vice Presidents and their terms in office, and 500 pages of reading in a weekly test, history goes on for an intolerable length of time. The historical time line too easily (and too frequently) disintegrates into a time-space continuum with the student biding time and occupying space while the U. S. History class drones on without him. While no student in the Oregon system escapes U. S. History, the problem is to keep U. S. History from escaping the student.

To involve a student in U. S. History would be to spark his imagination, to bait him to independently search out factors underlying major issues in history, to challenge him to match wits with major decision makers in U. S. History. Until a few years ago the suggestion that student interest and involvement could be aroused and sustained would have been unattainable. Today, by integrating the simulation approaches with existing methods, the active involvement of students in U. S. History, although an ambitious project, is possible, and in fact, has been demonstrated by Teaching Research and others to be feasible. Furthermore, the transposition of the above glowing, but vaguely defined goals into measurable terms is possible, and Teaching Research is presently collecting empirical data to demonstrate these outcomes.

The project involves two phases. The Materials Development phase of the project involves four efforts: (1) An examination of existing materials to determine the proper "fit" for simulations; (2) Working with an Oregon COMPACT committee acting in an advisory board capacity to define objectives and determine content; (3) Developing and revising prototype simulation games; and (4) Specifying methods for integration with present materials and procedures.

The Inservice Training phase of the project has already begun with the conducting of a two-day orientation workshop. Content included: (1) The application of simulation in social studies; (2) How to use simulation specifically designed for U. S. History; (3) Sharpening teacher specification of objectives; and (4) Developing competencies in evaluation of the effectiveness of the simulation. Monthly half-day, follow-up regional workshops to assist, trouble shoot, and provide additional information and materials are being scheduled monthly throughout Oregon. On these occasions, prototype simulation materials will be given to teachers with instructions on their use, and feedback will be sought to revise these prototypes after the teachers use them. In this way, the prototypes will be tested and redesigned to assure that the simulations are accomplishing stated learning and affective outcomes.

This entire program extends over a two-year period. During the first year, the products of the effort will include:

(1) U. S. History simulation games, tested and revised, which are compatible with existing course materials;

(2) The training of social studies teachers in the competencies required to use simulation techniques;

(3) Specified objectives for a U. S. History course;

(4) Initial evaluations of the simulation components of the course.

The second year would be directed to implementation and evaluation of the effectiveness and impact of the course as used in the classroom, in addition to the continued design of simulation exercises. The end of the second year would provide a "finished product" which would include:

(1) A U. S. History course integrating simulation games and existing materials and procedures;

(2) The materials necessary for the teacher to conduct the integrated course;

(3) Teachers trained to conduct the integrated course;

(4) A training system including materials for the future training of teachers; and

(5) Evaluation of the effectiveness and impact of the integrated course and the training program.

Other Activities

Language and Thought Games. Acquiring effective communication skills is particularly difficult for the disadvantaged child from a bilingual or foreign language background. Thus that child enters school with a double handicap. A project has been initiated under the direction of Dr. Jack Crawford and Mrs. Cathy Kielsmeier to investigate the effects of language development techniques using a learning game approach designed to maintain:

(1) the initiation and maintenance of a high motivational level;

(2) the frequent emission of linguistic responses;

(3) immediate and dramatic feedback to indicate appropriateness of responses;

(4) the use of language as a vehicle for problem-solving;

(5) the development of language-based conceptual frameworks; and

(6) effective instruction employing only teacher-aides or older children.

The approach is being used with Mexican-American children, Russian-American children, and Indian children. In one experiment with Mexican-American children, the game approach was found to be greatly superior to usual classroom instruction or placebo "game-like" exercises not designed for language development on an expressive language test developed for the study.

Advanced Special Media Institute. A one week institute for directors of Modern Foreign Language Institutes and their key staff members is planned in late March. Objectives of the institute are:

(1) to bring participants into an awareness of media alternatives in modern foreign language training;

(2) to promote an awareness of the potential contribution of simulation and gaming in modern foreign language instruction; and

(3) to provide an environment conducive to the study of alternative program formats for modern foreign language institutes.

Featured at the institute will be a series of planning exercises that will allow participants to explore new ideas, new approaches to instruction, or new institute formats in a productive and somewhat competitive atmosphere. Special emphasis will be placed on simulation in all its forms (machine or media-oriented simulation, simulation games, and non-simulation game techniques).

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Kersh, Bert Y. Simulation in teacher education. *Programmed Instruction*, 1963, 2, 3.

Wallen, Carl J. *Developing referential categories with instructional simulation*. Monmouth, Oregon: Teaching Research Division, Oregon State System of Higher Education, 4 pages. 1966 (Mimeo).

I. Simulation: An Overview

Paul A. Twelker

The chapter defines simulation and indicates the boundaries of simulation. Once this is done, some crucial assumptions that underlie the use of the technique for instructional purposes will be discussed. Finally, some of the reasons and rationale for using simulation will be presented. Throughout the discussion, reference is made to research directions that are relevant to the design and use of simulation for instruction.

It has become commonplace to open a discussion of simulation with phrases such as, "Simulation means many things to many people" or "Simulation is a popular but slippery notion that may be traced back to the beginning of time." However trite, these phrases accurately depict the situation. Simulation, in its various and sundry forms, seems to have become established in many scientific endeavors, from operations research to military training. The current popularity of the term "simulation" may be attributed in part to mass media, especially commercial television, which provides its home viewers with on-the-spot reports of the launching of space rockets, complete with simulated demonstrations of various phases of the astronauts' journey. Also, in the past couple of years, advertisers have been asked to tell the public when a demonstration of a particular product is "simulated."

It is interesting that the term "simulated" carries somewhat different connotations in each of these instances. In the first example, the meaning of the term closely parallels the dictionary definition - the assumption of the appearance of something without having its reality (Webster, 1966). For example, light produced from an electric lamp may be termed simulated sunlight. Thomas and Deemer (1957) paraphrase Webster in the following way: "To simulate is to obtain the essence of, without the reality." An astronaut's coupling of two space vehicles may be termed a simulated demonstration since it is difficult to film in space for television presentation, and so it is accomplished in the laboratory. Yet, the demonstration clearly shows the essence of what is thought to happen in real life.

On the other hand, the second example of the use of "simulated" in television demonstrations often parallels another popular usage of the term that refers to the assumption of superficial resemblances, often for the sake of deception. This usage has been adopted in the biological sciences, where simulation is defined in A Dictionary of Scientific Terms as the "assumption of features or structures intended to deceive enemies, as forms of leaf and stick insects, and all varieties of protective coloration." Many simulated demonstrations and television commercials might better be termed "exaggerated" demonstrations, and this author sometime wonders if the word "deceptive" might even be more descriptive than "exaggerated." Nevertheless, the simulated demonstration does show the essence of what might happen in real life. The only problem from a consumer's point of view is to determine the authenticity of the demonstration in terms of the probability of its happening under all but the most ideal conditions in real life.

A Word About Definitions

Basically, every definition of simulation takes the form of, "Simulation is an_____of (a)____." Two types of words or phrases are used in the first blank: words that connote a process and words that connote a product. In the first instance, simulation involves the individual in actually doing an activity, such as constructing, operating, manipulating, or representing. In the second instance, simulation involves a more or less tangible product such as a game or a model. The distinction essentially is between simulation as an act and simulation as an entity. In the first instance, the means or techniques involved in simulation are inherent and important in its meaning, while in the second instance the end product of simulation is emphasized. This is pointed out in one dictionary's definition of the noun, simulation, as: (1) the act of giving a false impression, and (2) false resemblance. The distinction is also illustrated by a boy operating a model boat in contrast to the model itself.

Several types of phrases are used to complete the definition. Essentially, they either connote an object, an action, or a system. Words such as "game," "model," "features," "structures," and "reality" are commonplace. What this word is depends on large part on the subject matter or discipline in which the simulation is used.

Several examples should suffice to show the broad meanings attached to simulation. In social science, simulation may be either the constructing and manipulating of an operating model, or it may be a representation of reality (cf., Guetzkow, 1962). For other social scientists, simulation is the study of structures in a laboratory (Zelditch and Evan, 1965). In education, simulation may mean the creating of games (Cruickshank, 1966) or a model of a system (Beaird and Standish, 1964, Cogswell, 1965). Or it may refer to a decision-making exercise structured around a model of a business operation (Greenlaw, Harron, and Rawdon, 1962). In biology, simulation is defined as an assumption of features intended to deceive (Dawson, 1962). For the behavioral sciences, simulation is a technique of substituting a synthetic environment for a real one (Kennedy, et al., 1960). Note that in this last definition, the writer leaves no doubt that an act or technique is involved in contrast to a simple product. In other cases, we cannot be sure what the author means without examining in detail what is simulated, how it is simulated, and for what purposes. Harman (1961), in his review of some definitions of simulation, states that all of the definitions have in common the characteristic of substituting other elements for some or all of the real elements of the system. He suggests that "perhaps the simplest and most direct definition of simulation is merely the act of representing some aspect of the real world by numbers or symbols that can be easily manipulated in order to facilitate study." McCormick (1964) gives a similar definition, but perhaps a little broader: "Simulation consists of some type of reproduction or representation of an actual or conceptual physical object, system, process, or situation, or of a theoretical construct." Note again that these two definitions point up the two ways in which the word is used. For Harman, simulation is an act of representing or a representation, depending on the interpretation given. It should also be emphasized that the fact that one person thinks of simulation as a device, while another person thinks of simulation as a technique for setting up the device, is not undesireable. It simply points up the two accepted meanings of the word.

In summary, simulation may be thought of in general terms as (1) a technique of modeling (physically, iconically, verbally, or mathematically) some aspects of a real or proposed system, process, or environment, or (2) a model (physical, iconic, verbal, or mathematical) of some aspects of a real or proposed system, process, or environment. The usage which might be adopted by an individual would depend largely upon his discipline, and the use to which the simulation is put.

Some Uses of Simulation

To illustrate the general definition of simulation, let us examine briefly three uses of simulation: (1) the generation of information about an operational or proposed system, processes, or environment (research); (2) the generation of new systems, process, or components (development); and (3) the development of knowledge or skills (instruction). The common characteristic, whether the scientist's main objective is to analyze a system, develop a new system, or communicate information about a system, is that the essence of the real life situation is obtained, but without all of the particular reality.

Generation of Information (Research)

Scientists are constantly asking questions and seeking answers. Simulation furnishes a powerful vehicle for the analysis of systems, things, or processes that may be too complex or too large or too fragile to observe in real life. When scientists analyze a system or component, knowledge is a product. This knowledge may be used to design and develop new systems, and in this sense, the distinction between research and development is simply a matter of degree. Frequently, applications of simulation for research are but a first phase of an activity whose eventual goal is the design and development of a new system or component, not simply the provision of general principles or data. It goes without saying that aspects of this newly generated information may be communicated directly to individuals through the use of simulation.

The use of simulation for research may be thought of in two ways. First, simulation may be involved in the conventional psychological experiment. For example, the experimenter informs a subject of the behavior that is expected of him and then presents the subject with pre-designed stimulus events, such as a pictorial lesson or a verbal lesson, each dealing with "mechanical advantage" and "first class levers" (cf., Gagne and Gropper, 1965). Several dependent measures are taken following the original learning of either the pictorial or verbal material. An examination of the materials used shows that the pictorial demonstration illustrates the concepts of mechanical advantage and simulates events in the real-life (operational) situation, in the same manner, the demonstration where words were used describes what occurs in real life. Again, reality is simulated. Both demonstrations obtain the essence of the operational situation, without the reality, and in this sense, involve simulation. It should be pointed out that the events that occur during a typical psychological experiment are atypical of events in real life. In real life, an individual's response in a situation is followed by events (feedback) from other components in the situation. McCormick (1964) illustrates this superbly. In real life, if a driver of a car veers over the center line, this may bring about interactions with other drivers. In a typical psychological experiment, this type of interaction doesn't exist, to say the least. The stimulus events are discrete events, taken out of context, with little or no reference to the system as a whole from which they are drawn. When simulation is thought of in these terms, the meaning of simulation emphasizes a representation or a model rather than the activity of constructing the model.

There is a second way in which simulation for research may be thought of. It involves what is called "systems research," which typically provides a greater degree of interaction than with the controlled laboratory experiments. Systems research that uses simulation represents the operational situation within the laboratory while at the same time providing control over the situation that is the forte of conventional psychological experimentation. Harman (1961) points out some specific advantages of simulation as a research technique: (1) it can compress or expand real time (for example, a school system operation extending over several years may be simulated in minutes with a computer to study long-term trends), (2) it provides the ability to experiment, test, and evaluate new systems for proposed changes in advance of having to make firm commitments, (3) it makes for more economical experimentation, both in terms of time and money; (4) it permits the replication of experiments under different conditions. When simulation is used in these terms, note that it may refer either to an act or an entity. Simulation may refer to the activity of constructing a model as well as to the model itself.

Literally hundreds of examples may be called from the literature to illustrate the research application of simulation. School systems have been analyzed (Cogswell, 1965; 1966); the decision-making behavior of businesses has been examined (Bushin, 1964), and the dynamics of group behavior have been investigated using simulation (Briggs and Johnston, 1965, 1966, 1967; Briggs and Naylor, 1964). Other applications have involved research areas such as the study of the interaction of human behavior with computers and information processing systems, (Kennedy, 1962), driver research (Halbert, 1963), perceptual development, (Gyr, et al., 1962; 1966a; 1966b), international relations (Guetzkow, 1963), cognitive processes (Green, 1964), and aircraft performance (Floddy and Paul, 1958). In each application, the simulation was a research tool or vehicle used to generate information about an object, process, or system. The simulation was a means to an end, not the end itself. However, in most instances, the term simulation still carries the connotation of the dual meaning — simulation is a technique of modeling, but it may also refer to the model itself.

Generation of New Objects, Processes, or Systems (Development)

As noted above, simulation furnishes a powerful vehicle for the analysis of systems. Often, this information may be used to design or develop new systems or processes. When an individual wishes to design a new system, it is often difficult to "think on paper" — that is, to attempt to determine all of the potential problems and occasions for decision-making at the abstract level. When this situation arises, the representation of reality via simulation offers the designer a powerful technique for developing the system, trying it out, and revising it, all within the confines of a laboratory. An excellent example of this use is the simulation of a hydroelectric installation. In dam construction it has become almost mandatory to first build a scale model of the installation to determine construction problems and possible solutions before the actual dam is built. Although the simulated dam is expensive to build and operate, its cost is but a fraction of the money saved by such procedures. Bushnell (1963) summarizes this use of simulation nicely: "When the design of new systems or the introduction of innovations into ongoing systems is in question, simulation can be used to manipulate variables to determine in advance the effect of changes. New systems can be tested or evaluated in advance of having to make firm commitments. Information about unpredictable effects that could be costly if they occurred in the real situation are also yielded."

To further illustrate the developmental use of simulation, consider the work of the Rand Corporation on game-simulation and long-range logistic planning for the United States Air Force (Rauner, et al., 1961). These efforts were designed to minimize the difficulties in making the transition from paper plans to full-scale operational situations. The authors used "game-simulation" to describe a technique that incorporated both the exploratory, unstructured characteristics of business or war games and the more rigid, controlled qualities of traditional computer simulations. Their experiments involved human decision-makers interacting with a simulated environment, represented partially by other humans and partially by computer programs that simulated the real world environment. The results of these exercises were expressed in terms of cost-effectiveness measures of various alternatives, as qualitative judgment about the feasibility or desirability of one organizational form or another, as decision rules, as information flows, and so forth. These results were tangible representations of future plans and helped planners by portraying activities and results at a level of detail necessary to make paper plans operational

In summary, simulation allows the individual to try out the prototype system in his effort to determine potential problems, special design features, and even occasions for decision-making that he should know about before final implementation. The end goal is a product, not simply information.

Development of Knowledge or Skills (Instruction)

The third use of simulation is as a training or instructional medium. To elaborate, simulation may be used in an instructional setting to: 1) present information; 2) elicit responses or exercise the student; and 3) assess performance. When simulation is used to present information, its meaning most closely parallels that of an entity -- perhaps a motion picture, a model, or a mock-up. The simulated object or event may be used as a concrete referent so that labels may be attached to exemplars (cf., Wallen, 1966). Not only may information be presented for the purpose of actual training or instruction, simulation may be used to indoctrinate individuals or to exhibit the feasibility of complex systems (cf., Harman, 1961). Here, the demonstration role of simulation is apparent. Also, simulation in a demonstration role may be used to simply develop enthusiasm among individuals for a particular activity or for a proposed change. Note that this differs from presenting information and desiring students to learn this information. If employees of a business firm expressed hostilities toward proposed changes, simulation might be used to exhibit the revised operation to reassure them or to present their new duties which might have to be learned (cf., Morgenthaler, 1961).

Simulation may also be used to elicit responses that are required in real life. An example is found in the unique application of simulation in teacher education as developed at Teaching Research (Kersh, 1961; 1963a; 1963b). Classroom simulation, in its prototype form, creates for the student teacher many of the relevant features of a single classroom situation called "Mr. Land's Sixth Grade." Mr. Land is the hypothetical supervising teacher with whom the student teachers work during this simulated experience. A complete cumulative record file is available on each child in addition to printed descriptions of the hypothetical school and community. The technique of filming the youngsters in the simulated class so that they appear to be reacting to the student teacher during the sequences is employed in sixty different problem sequences on sound, motion-picture film. In each case, the student teacher is expected to react to the film as though he were in a real classroom. Classroom simulation is based on the supposition that exposition of educational methods or principles could be expected to help the teacher talk about teaching, but only classroom experience (simulated or real) could train the beginning teacher to teach. It has been suggested that the classroom simulation in this form helps students practice the discriminating of cues that signal potential problems that require immediate attention, make decisions in simulated conditions without fear of censure or embarrassment, and to modify their behavior on the basis of this feedback (Twelker, 1967).

Another example of this use of simulation is the familiar academic game where real-life situations are simulated in a competitive activity. In the well known family entertainment game of Monopoly, players compete with each other for properties and the eventual wealth that comes from owning hotels on strategically located places. An example of an extension of this game to an academic business game is the American Management Association management-decision course.

A third aspect of instruction where simulation is of use is in the assessment and evaluation of performance. The assessment of performance may be carried out with simulation in all sorts of activities, and offers a unique opportunity to assess performance in a life-like setting that is often times untestable by other means. For example, it is difficult to think of a paper-and-pencil test as being adequate to test the performance of astronauts in a space vehicle coupling activity.

Schalock and his colleagues (Schalock, et al., 1964, Beaird, 1967) have shown that as test stimuli become more representative of the behavior to be predicted, and as the opportunity for response approaches the freedom characteristic of life situations, the power of prediction increases. Beaird points out that "the extent to which prediction was possible with the more life-like test is essentially unprecedented in the educational and psychological literature." He goes on to state that at least 50 per cent of the variance in the criterion that was being predicted to was accounted for in each of fifteen spearate criterion measures that represent a concrete teacher behavior in the classroom and as much as 75 per cent of the variance was accounted for in some instances. The question of simulation for performance evaluation is discussed further by Gagne (1954; 1965), and Frederiksen (1962), Thorndike (1947), and Gibson (1947). The reader is also directed to the chapter by Dr. Schalock for a thorough examination of the use of simulation for testing.

Again note that the use of the term simulation in this context primarily refers to the tangible model or representation of reality rather than an act of representing. In the work of Schalock's, films were used to simulate a complex teaching environment. The films obtain "the essence of, without the reality."

Toward a Definition of Instructional Simulation

In the remainder of this paper, our consideration of simulation will be limited to that which is primarily used for instruction. It is this use which is of primary interest to educators and instructors.

How does one go about defining "instructional simulation?" Are techniques such as role playing, sociodrama, psychodrama and case studies properly thought of as instructional simulation? What about moot courts, learning games, practice teaching and instructional motion pictures? It is clear that each technique includes elements of non-reality. There are a number of approaches that we may use in setting limits around what we mean by the term simulation.

The "Classification" Approach

Here we simply list every "simulation" we can find, and then deduce a series of limitations or constraints from these examples. Unfortunately, this approach will advance technology very little. We could hardly assume that a given "simulation" expert could even agree with another expert on such a classification. Further, such an approach will not lead us to exact limits. It will only lead to statements such as, "If your technique appears like any of these, it is a simulation." The end result will be a limitation as broadly defined as the list of simulations that are included. A more sophisticated classification approach might be to identify simulations on the basis of the type of response involved, e.g., drawing, loading, writing, assembling, directing, supervising, and so forth. Hopefully, this approach would lead one to specifying which responses are appropriate for simulation and which responses are not. It would be presumed that this in turn would lead to the drawing of limits around what is meant by simulation. For example, "Simulation is a technique that involves such-and-such responses." Unfortunately, the classification of responses depends upon an intial classification task of deciding what simulations are to be looked at in the first place. This leads us directly back to the problem discussed above. If it were not for this unfortunate concomitant of this approach, it might possess some merit.

The "Head in the Sand" Approach

Repeated failures at making some sense out of simulation as an area of study often leads to an approach that is characterized by the ostrich with its head in the sand. "If you don't ask me why my device or technique is a simulation, I won't ask you why yours is." This approach states that it's not important that a technique be considered in the generic sense as a simulation. Rather, it is a simulation by edict since it resembles another technique previously called a simulation. Or perhaps, it is a simulation because the word is in vogue and seems appropriate. This approach is not entirely without merit if one thinks that the time spent in the mental exercise of drawing limits around simulation might be more profitably spent in designing new simulations. "Stop theorizing and get to work" would be the battlecry of the proponents of this approach. In some ways, this approach has merit. If the label, "classroom simulation," for example, seems to communicate to other people, why worry about such things as the meaning of simulation in general?

The "Death of Simulation" Approach

After reading reams of reports and supposed definitions of simulation, one might very well advocate that we stop using the word altogether to refer to a particular class of devices or techniques. This approach, in other words, denies that simulation as a noun carries any useful meaning since any definition will inevitably be vague and misleading. Such a drastic move is not unwarranted. Consider, for example, an individual who attempts to define simulation. He compares simulation "X" with a motion-picture training film and ends up with a statement of "no significant difference." He then turns to learning game "Y" and compares it with Monopoly, and he arrives at the same conclusion. Finally, in desperation, he compares another so-called simulation with sociodrama. Still, he cannot distinguish between the two since all of the techniques involve elements of non-reality and role-play. The logical conclusion he reaches is that all that takes place in instruction, short of using real life conditions, is simulation. Since this is somehow unacceptable, he concludes that simulation as a generic term is useless, and suggests that it not be used at all.

An alternate version of this approach suggests that simulation as a descriptor of a specific thing be discarded, but simulation as a verb be retained since it probably has a useful meaning. The outcome of this approach is to say that such-and-such a procedure uses simulation -- that is, "the obtaining of the essence of, without the reality," for example. Again, the result is still the same as before -- under the umbrella of simulation (this time as a verb), every conceivable instructional device or technique would fit. It is clear that in the generic sense, motion pictures should not be called a simulation since the connotation here is potentially ambiguous and useless.

The "Let's Try Harder" Approach

This writer believes that it is possible to define "instructional simulation" in terms that are meaningful and useful, and without resorting to the three approaches mentioned above. The advantage of having such a definition is obvious. The task of developing simulations would be far easier if general guidelines could be specified for designing a class of techniques called "instructional simulations." Otherwise, each new simulation must be designed "from scratch" since no guidelines could be determined that would hold for such a class of techniques or devices. The danger of the "Let's start from scratch" approach is that it may lead to the inefficient use of time and money, and may result in a shortcut method of design where existing simulations are duplicated. Under these conditions, the designer proudly displays his technique as the offshoot of the famous "XYZ Simulation." This is unfortunate because the designing of a simulation solely on the basis of revision or duplicating of another simulation technique hoping that a "fit" exists, usually leads to a less-than-adequate instructional system.

The "Essence" of Simulation for Instruction

Recall that simulation may be thought of both in terms of a technique of modeling as well as the model itself. When simulation is used for instruction, the emphasis is primarily on the latter connotation. The unique advantage of simulation is summed up in the Thomas and Deemer (1957) definition of simulation: "to simulate is to obtain the essence of, without the reality." Harman (1961) points out that substitution of "essence" for "appearance" which is in the dictionary definition is a vital distinction. Simulation contains the important parts of, but not all of, reality. Simulations do not have to look like the real-life counterpart, but they do have to "act" like the real thing.

What does it mean to obtain "the important parts of?" First, it is clear that when a simulation includes important aspects of reality, it omits other elements of the real-life situation. When simulations are designed, unimportant elements from real life are subtracted. In the case of simulated displays, there is a reduction of information from the real-life source -- information that is in some sense unnecessary for the learning of the task. We might think of simulation in the following terms:

Simulation = (Real-life) - (Task-irrelevant elements)

where real life, in an instructional sense, is composed of task-relevant as well as task-irrelevant elements.

A simulation not only omits certain elements of real life, but it represents some of the elements that are included. In one sense, a simulation is a caricature in that some of the attributes of real life are not realistically represented. This representation may appear as a distortion or magnification or exaggeration. For example, a simulation of the atomic structure of a DNA helix may represent (distort) size. That is, the simulation is built to a scale, say, two centimeters to one Angstrom unit, so that a group of students may see the simulation without the aid of magnification. On the other hand, the representation may reflect more the characteristics of substitution or addition. The model of a DNA helix may use links of plastic to represent iconic bonds. In real life, these bonds are invisible, and are certainly not composed of plastic. In this sense, the represented link is a caricature of a real bond. With this in mind, we may think of simulation in these terms:

Simulation = (Real-life elements) + (represented elements
of real life)

It is clear that a simulation designer not only has a task of choosing what elements of real life to include and what elements to omit, but he also has a choice of deciding how task-relevant elements are to be represented. In the literature, these considerations usually fall under the general topic, fidelity of simulation or precision of representation.

Omission of Task-Irrelevant Elements

By task-irrelevant elements we mean those elements that are not essential for the learning of the particular task. Note that these elements must not be irrelevant for the conduct of the task in real life -- if this were the case, simulation would be useless for instruction. The determination of which elements are task-irrelevant and which are task-relevant is closely tied to the instructional objective. For example, if the desired behavior were "List the principles involved in managing a class," many elements in real life would be "excess baggage" as compared with an objective such as, "manage the class." There is little need for an instructional system that includes the students (simulated or real) and information about the students with the first objective. Learning could proceed nicely with verbal descriptions of the principles. In the other objective (i.e., manage the class), the student must transfer what is learned to an actual behavior that requires some practice in performing it. If the system were novel, it is doubtful that merely presenting a learning situation where recalling the principles that may be applicable would enable the learner to perform the activity. Note that the transfer we are considering is from the instructional experience to real life. Transfer is a crucial aspect of simulation and will be reserved for consideration later in this paper.

Other factors are important in the determination of what elements are irrelevant to the learning of the task and hence subject to omission. For one, omission of elements may provide control in the instructional situation when one or more elements in real life would produce unpredictable occurances that may be dangerous to the learner. For example, if the desired terminal behavior is, "Pick up a rattlesnake and milk its venom," the instructional situation would be highly dangerous to the naive learner. Simulation might be used to bridge the gap from a "textbook" milking (i.e., looking at pictures or a diagram of the milking) to the real-life behavior itself (i.e., performing the milking). At one extreme a live rattlesnake, but with the venom removed (omitted) might be used. At the other extreme a dead snake might be used. In this case, the real-life element of life itself has been omitted, together with other features such as the ability to bite and so forth.

Another factor that is important in the task of labeling irrelevant elements is stage of training. In the preceding example, a live rattlesnake (where no elements of real life are omitted) might be appropriate for latter stages of training while a rubber snake (where many elements are omitted) would be more appropriate earlier in instruction. The success that a simulation designer has in determining the task-relevant elements will determine to a large extent the success of the simulation in meeting the objectives of instruction. The designer faces three outcomes of his efforts:

1) task-relevant elements as well as some task-irrelevant elements are included;

2) some task-relevant elements are omitted and some task-irrelevant elements are included;

3) task-relevant elements are included and task-irrelevant elements are omitted.

In the first instance, it is possible that the closer simulation approaches real life unnecessarily, the more costly it will become. Further training effectiveness may suffer since the trainee is forced to consider irrelevant elements. It is a well established fact that when too much information is presented to the learner, that is, when the learner is overloaded or in human engineering terms, when signal input rate exceeds operator information-processing capacity, signals are not only unidentified but they function as a distraction. The psychological literature abounds with instances where too much information may cause confusion and a detriment to transfer performance. Yet, the question of just how much information to omit is largely unanswered. Travers' work (1966) has only touched the surface of the whole matter of visual and auditory compression.

In the second instance, the designer clearly "misses the boat" if he includes the wrong (task-ireelevant) elements and excludes the right (task-relevant) elements. It would be a wonder if much would be learned in this circumstance.

The situation represented by the third case is one where the simulation has a chance of being effective. It will possess all of the elements that are necessary for the trainee to learn, and will exclude all that is irrelevant for his learning of the task. Also, it might even be the most economical, in terms of the three outcomes mentioned, since irrelevant features are excluded. Here again, the matter of the appropriateness of including some task irrelevant elements to enhance transfer especially in later stages of training, is important to consider. Research by Twelker (1964a; 1964b) and others have shown that instructional conditions optimal for learning certain objectives may not at all be suitable for other objectives, e.g., transfer.

Representation of Task-relevant Elements

Once the task-relevant elements have been identified, the simulation designer must decide how best to represent those elements. For present purposes, it seems appropriate to consider four categories of elements that may be represented: 1) stimulus situation; 2) response; 3) feedback; and 4) context. It is clear that if any element of any of these four categories is represented, the result is a simulation in the general sense of the word -- the essence is obtained without the reality. Presently, we shall examine simulation from a more restricted point of view, and draw limits around what we mean by "instructional simulation."

Types of Stimulus Situation Representation

By stimulus situation is meant the cues that are presented to the learner that serve to elicit a response. In the most simple terms the stimulus may be a combination of letters that stand for two phonemes in a paired-associate task. In the case of gunnery practice, the stimulus is a target. In psychological terms the stimulus that is represented is an external stimulus, defined as an energy change in the environment that produces a response, as compared with an internal stimulus that originates from within the organism (e.g., hunger pangs).

Unfortunately, there exists no simple way of classifying stimuli that is known to this writer. Further, an attempt to develop a taxonomy on purely physical criteria (e.g., is it a picture or a symbol?) will end in failure since communicator intent must be considered. For example, a model of Uncle Sam might be termed a concrete representation if it stands for a person. If the model, Uncle Sam, stood for a country, should it still be classified as a concrete representation. The categories mentioned below are better thought of as possible ways in which a stimulus might be presented, and do not necessarily represent mutually exclusive categories. A stimulus could be classified into more than one category.

The stimulus that is given to a learner might be a real-life stimulus, and, as such, nothing is simulated. A real life stimulus that is presented to the learner may involve one or more senses: vision, hearing, touch, taste, or smell. Most often, only the audio and visual modes are used in instruction, and our discussion will be limited to these modes.

If the instructional designer does not wish to present real-life stimuli, he must then simulate real life. Real life may be simulated in a variety of ways. The stimulus may be a concrete representation. A model of an apple that possesses many of the attributes of an apple, such as shape, size, color, and texture, but is made of wax may be termed a concrete representation. It is clear that the concrete representation may very closely approximate the real-life apple. It may even use real seeds and a real stem. But in some way reality has been altered by omission and representation of elements.

There are degrees of concrete representation. At one extreme is a nearly perfect representation of an apple as noted above. At the other extreme may be a gross caricature of a real apple -- a red, hollow shell that emphasizes certain features for the sake of instruction. In this case it might be called a "mock-up" in media terms. The important thing to note is that concrete representation allows the learner to experience directly the phenomena. The learner may see, and some cases hear, touch, taste, and smell the simulation. Stimuli that may be classified as concrete representations are three-dimensional, thus allowing the learners to interact with the stimulus. Edling (1966) suggests that "all senses can be employed to provide cues to the learner" in the case of three-dimensional stimuli.

The stimulus may be an iconic representation. Iconic representation, as described by Bruner (1966) "depends upon visual or other sensory organization and upon the use of summarizing images."

> "Iconic representation is principally governed by principles of perceptual organization and by the economical transformations in perceptual organization that Attneave has described--techniques for filling in,completing, extrapolating."
> (Bruner, 1966, p. 11.)

Iconic representation may deal with pictures -- with sense of vision. Edling (1966) notes that representations that are iconic are " 'objective' because elements in the representation (the picture or drawing) correspond to specific elements in the reality." The key in iconic representation is correspondence. The elements in the model (in the general sense of the word) "contain cues that make it possible for a learner to associate an object with visual representation of that object without prior association with the object itself" (Edling, 1966, p. 38).

Edling (1966, p. 39) presents a list of "objective" visual stimuli that is helpful in realizing the wide range of iconic representations.

Motion pictures, with illusions of 3-D in color
Motion pictures, with illusion of 3-D minus color
Motion pictures, 2-D, in color
Motion pictures, 2-D, minus color
Still pictures, with illusion of 3-D, in color
Still pictures, with illusion of 3-D, minus color
Still pictures, two dimensional in color
Still pictures, two dimensional, minus color
Painting (realistic), in color
Photograph of painting (realistic) minus color
Sketch (with shading)
Representational color cartoon (with animation)
Representational color cartoon (without animation)
Representational cartoon (minus color)

Note that as the iconic representation moves from the motion picture to the still photograph and to the cartoon, the number of cues that are available to the learner decrease.

Visual stimuli are not the only stimuli that may be iconically represented. Sounds may also be classified as iconic since they depend on perceptual organization. Sounds are "objective" in that elements in the representation (the recording of a bullfrog, for example) corresponds to specific elements in real life. Here again, there are degrees of representativeness. A stereophonic recording of the mating call of the bullfrog has more cues that correspond to reality than a recorded sound effect that sounds like a bullfrog but is produced by other means, for example.

So far, we have considered the representation of stimuli by concrete and iconic means. A third type of stimulus representation is analogue representation. By that, we mean most simply that the property of correspondence changes to non-correspondence. One property is used to represent another. Whereas iconic representation model relevant properties of real life by those properties themselves, analogue representation models relevant properties of real life by other properties, so that a code or legend is required in order to learn. "This condition requires that a learner have associations with the visual stimulus and the object it represents if the visual stimuli is to be associated with the object" (Edling, 1966, p. 40). The learner must know the code or legend in order to associate the representation with real life. For example, the flow of electricity may be represented in analogue fashion using water flowing through a pipe. The well-known cartoon fiture, Uncle Sam, is an analogue representation, since it stands for a country. In both instances, the learner must be told what the model stands for in order to learn. Examples of stimuli that are represented by analogue include:

Symbolic cartoons
Diagrams
Maps
Charts
Graphs

A final type of stimulus representation that shall be considered is symbolic representation. For example, numbers and words are symbolic models of real life. In one sense, it is a form of analogue representation in that the property of non-correspondence is still operative, and one property (e.g., a word Plato) is used to represent another property (the man, Plato). Yet, in terms of a continuum of realism, it seems that a large gap exists between maps and similar models, and symbolic representations, such as words. To this end, representation of reality by sumbols is best thought of as a separate category.

Types of Response Representation

By response we mean an observable change in behavior, this change being an activity usually effected by muscles. In a scientific sense, all that is required of a response is that it be measurable by some means. From an instructional point of view, a recitation of a poem, an identification of a target on a radar screen, and the handling of a problem situation in a classroom, are all responses. For our purpose, it seems appropriate to think of five types of responses. The latter four are representative of (or simulate) real-life responses:

(1) real-life response to real-life stimuli;

(2) enacted response (doing the task in a non-real-life setting);

(3) iconic response (drawing what would be done in a non-real-life setting);

(4) analogue response (giving a non-corresponding response in a non-real-life setting);

(5) symbolic response (saying, writing, or choosing among given alternatives what would be done in non-real-life setting).

A real-life response must be made to a real-life stimulus. If the stimulus is simulated, then the response should be regarded as representative of real-life since it is not made to real-life stimulus, and transfer is involved from the instructional situation to reality. Confusion will arise if this point is not clear. The basis for labeling a response "enacted," "iconic," "analogue," or "symbolic" is not whether or not the real-life response involves doing, drawing, writing and so forth. The basis of labeling is whether or not the response is representative of real-life in the instructional context, and how real-life is represented. The real-life response may take any form, but we are not distinguishing these forms now. The abovementioned labels of enacted, iconic, analogue, and symbolic only serve to identify the type of representation of the real-life response, whatever form it may take. In the simulation the learner may do the real-life activity (enactive response), draw the activity (iconic response), tell about it (symbolic response), or do something that is an analogue to the real-life behavior (analogue response). It makes little difference in this taxonomy what kind of real-life response it is that is represented.

With this in mind, let us examine each of the four types of response representations in greater detail. The enacted response is essentially doing what is done in real-life with the exception that it is elicited by a simulated stimulus situation. For example, in a learning game, a student may play the role of a Senator. He may make speeches. He may lobby, and attend conferences. But, this enactive behavior is elicited, not by the real-life legislature of that state, but by a series of rules and instructions for playing the game that simulates real life. The responses are enactive since he does what is usually done in real life. Enactive responses usually are characterized by an interaction with the stimulus, and are most realistic in terms of the four categories mentioned above. Enactive responses require the least interpretation by observers witnessing the behavior. Further, witnesses may mistake the response as real life if they fail to observe the stimulus. The iconic response is essentially drawing what would be done in real life. In designing an instrucational simulation, this type of response would probably not be used to any great extent. Yet, it definitely represents a class of responses that should be recognized. Needless to say, this type of response might require more interpretation on the part of an observer who witnesses the behavior.

The analogue response is elicited by an analogue stimulus. Recall that non-correspondence is the property of analogue representation. One property is used to represent another. Similarly, one response is used to represent another in an analogue fashion. This requires that the learner must transfer from the analogue response in the instructional situation to a real-life response. Theoretically, this transfer would be more difficult than transfering from an enactive response to a real-life response.

An example of an analogue response would be the turning of a faucet to restrict water flow, when the water flow represented electrical current and the faucet represented a switch. In real-life, the response would be an up or down motion with a lever, while in the simulated situation, the response would probably be a turning motion with the hand. Note that in both instances, the response is not thought of separately from the stimulus, since, in psychological terms, a stimulus elicits some response. Again, as is the case with iconic responses, the use of analogue responses may be somewhat restricted because of the transfer problem. It should be noted, however, that rarely would analogue responses be used apart from symbolic or enactive responses, so the problem of transfer may be minimal. Symbolic responses may serve as verbal mediators in the real-life situation.

A fifth type of response representation that we will consider is the symbolic response. Saying what would be done in a given situation, writing what would be done, or choosing among the given alternatives, are all types of symbolic responses. As is the case with symbolic stimuli, symbolic responses could be considered a form of analogue response. An example of a symbolic response in classroom simulation training, where problematic classroom episodes appear on a screen in front of the learner, and the learner is expected to respond to them, would involve the learner in telling what he would do in the problem response. If he chose to act out the response, it would be classified as an enactive response since he was doing what would be done in real-life except to a simulated stimulus. Conceivably, the student could even choose to draw his response in which case it would be termed as iconic response.

Types of Feedback Representation

We need not concern ourselves with types of feedback representation in detail since they parallel those of stimulus representation. In instructional situations, feedback is a stimulus following the learner's response, and may possess the various features discussed under stimulus representation.

Types of Contextual Variables

A dictionary definition of context refers to the whole situation of the background or environment that is relevant to the (instructional) situation. As such, it would be difficult to distinguish context from stimulus situation in many cases. This writer has chosen a narrower meaning for context. Context is learner-oriented. It refers to how the learner perceives the situation: Is it real or is it non-real? The learner brings to the instructional situation certain elements that are not necessarily apparent to a non-participant observer . For example, an observer of a student teacher may not see the supervisor and may not be told that a student teacher is conducting the class, and think that what he observed was in fact actual, unsupervised teaching. Yet to the student teacher, it may be far from the real thing if the supervisor, even though absent for a moment, may still exercise control and influence over the class. In some way, the context for the learner is different. It has been altered. The children (the stimuli) may be real life; teaching (the response) may be real life; the consequences of this behavior (the feedback) may be real life. But the fact that he is practicing under supervision changes the context. What is omitted in the practice teaching example, in terms of context, is the absence of direct control over the class. Of course, as the term progresses the student teacher is given progressively greater autonomy. Thus we see that one important contextual variable is the presence of a supervisor or evaluator of performance.

Another important contextual variable is the quantity and type of stress. In an instructional situation, the learner perceives of the situation in a different manner, and this may be related to the degree and type of stress in the situation. In an aircraft simulator, no amount of "bungling" will produce an actual crash. In a simulated classroom, errors in judgment do not produce actual chaos. In cross-cultural simulation training, saying the wrong thing to a village chief will not produce actual rebellion. The context is different from real life, and this difference may be expressed in terms of stress. In the instructional situation is relative safety, while in real life may be jeopardy; the learner perceives this. The contextual difference requires the learner to transfer to real life after instruction, and this transfer may be initially difficult. Examples are plentiful of individuals performing more than adequately in target practice, only to freeze or misfire when confronted with the real enemy and real bullets. Needless to say, it is up to the instructional simulation designer to maximize the probability of effective transfer.

In some cases, stress as a contextual variable may be rather effectively simulated. One example is a ninety-two step procedural skills trainer that trains an individual to activate a missile (Cox, et al., 1965). Confronting the trainee at all times is a panel with a red light that glows when a particular missile sub-system is over-heating and endangering the mission. The objective of the mission is for the trainee to ready the missile for firing without delaying that may cause over-heating of this particular sub-system. Even though the trainee perceives the situation as simulated, the introduction of this factor seems to be effective in simulating actual stress. Another example of stress produced under simulated conditions may be found in classroom simulation training (cf., Kersh, 1965; Twelker, 1967). Here, it is not uncommon for several students during the course of training to become quite frustrated when confronted with a problematic episode which they are unable to handle.

Other examples show individuals having an amazing capacity to "throw themselves into the situation." This phenomenon has been remarkably illustrated in a sequence shown by the popular television show, Candid Camera. The situation involved an individual delivering a key to a particular office. The individual was requested to sit in the waiting room and wait until the gentleman to whom the key belonged appeared. A television set in the waiting room was then turned on and the messenger observed what he thought was a "soap opera," but which in fact was a staged plot involving the key which he was attempting to deliver. Although the stimulus was presented by means of television, the individual still interacted with the drama as though it was real life.

Some Examples of Classification

Given the types of representation discussed above, it is quite easy to classify various devices and techniques that are called "simulations" or "simulators." For example, classroom simulation (Kersh, 1963a; 1965) uses an iconic stimulus situation mode, usually motion pictures, although still pictures have been used. The responses that are elicited are either enacted in front of a large, rear projection screen, or "arm-chaired" -- the learner explains how he would respond but without acting out the response. Feedback may be presented either by film, showing the probable class reactions to his behavior, or symbolically by telling him what might happen. The reader is left to assure himself that other instructional techniques may also be classified in the same manner.

Type of Representation

Device or Technique	Stimulus Situation	Response	Feedback
Classroom Simulation	Iconic Concrete	Enacted or Symbolic	Iconic or Symbolic
Link Trainer	Concrete	Enacted	Concrete
Carnegie Tech Management Game	Symbolic Concrete	Enacted or Symbolic	Symbolic
NAPOLI	Symbolic Concrete	Enacted	Symbolic Enacted

Figure 1. Classification of selected instructional "simulations" in terms of type of representation.

Three Types of Instructional Simulation

Now that the overall question of what types of elements in real life may be simulated (omitted and represented) has been answered, let us turn our attention to some constraints on the term, instructional simulation. Needless to say, we have set the stage for calling everything that takes place in instruction, simulation. After all, when one or more elements in the stimulus, response, feedback, or the context is omitted or represented, it may be said that the particular stimulus, response, feedback, or context is simulated. In fact, it has been shown that a given "simulation" may be classified in terms of what type of things are simulated in what way. It is clear that each of the above types of simulation fulfill the Thomas and Deemer definition of obtaining "the essence of, without the reality." Recall the three uses of simulation for instruction that were mentioned above: (1) presenting information; (2) eliciting responses; and (3) assessing performance.

For convenience, let us use the term "referential simulation" to describe instructional techniques that emphasize the use of simulation, in the general sense of the word, to present information or for demonstration. Star field projections, developed to a fine art by planetarium produces, are prime examples of simulators used for demonstrational or representational purposes. Planetariums can provide a simulation of the night sky, and other celestial phenomena, so realistically that it is often difficult to distinguish the simulated from the real. Much instruction could benefit from the wider use of concrete or iconic models that illustrate in a clearer way than words, concepts or principles that are being taught (cf., Bamford, 1955; Gropper, 1963; 1966).

For the second use, that of eliciting responses, or more correctly, providing opportunities for practice or exercise of previously learned principles, or for the trial-and-error learning of principles, let us adopt the term, "contextual response simulation." The appropriateness of this term becomes clear if we consider that the technique exercises the student or provides him with a context for response or practice. For the third use -- assessing performance, perhaps the term, "criterion simulation" or "situational response testing" best describes this application.

In the remainder of this chapter, the second type of simulation, contextual response simulation, will be discussed. Clearly what will be talked about will have application for the other two types of simulation. Yet, simulation, from an historical perspective, is best thought of in terms of contextual responses. Chapter V will discuss in depth, criterion simulation.

Contextual Response Simulation

Four features are characteristic of contextual response simulation:

(1) enacted or life-like responses are made to

(2) non-real life stimulus situations that

(3) provide feedback to the student *vis-a-vis* his behavior in the ongoing instructional context that

(4) offers control.

Let us examine each of these points in detail. Note that what is said has relevance to the consumer of simulations as well as to designer of simulations.

Enacted Responses

Enacted responses involve the learner in doing the task in a non-real-life setting. In contextual response simulation, the learner behaves as though he were in a real-life situation which demands the same behavior he is engaged in during the simulation exercise. The learner does not simply state what he would do under similar circumstances. Of course, the eliciting of "what I would do" behavior may be related to the objectives of instruction, but involves behavior that is incidental to real-life behavior. For example, the learner might engage in the evaluation of choices given to him, the problem being that real-life situations demanding decision making are not presented to the learner in multiple-choice test questions. Furthermore, as Frederikson (1962, p. 332) points out, written situations do not permit the instructor to assess the style of behavior that may be exhibited in real life, the corollary being that the student does not have an opportunity to practice the real-life behavior in various styles to discover which is most appropriate for him.

Garvey (1967 p. 6-7) has stated that the simulation technique is based on role-playing, which is defined as "the practice or experience of being someone else" which "requires the student to perform a role which he is not accustomed to playing" for the purpose of understanding the situation of another person or of relationships or of actions. In one sense, the restricted meaning of the term role-playing is appropriate. In learning games, the learner behaves as though he were in a real-life situation, but adopts a role of a senator, for example, in a legislative assembly. Clearly the student is "being someone else." Yet, in another sense, this definition of role-playing is too limiting. In some simulations, the emphasis is not so much on the adopting of another person's role as it is the adopting of the learner's own subsequent role that he will perform in real life. The performing of a role in propria persona is clearly seen in skills training with aircraft simulators, where the learner practices skills in a life-like situation. The classroom simulation technique developed at Teaching Research (cf., Kersh, 1963; 1963b; Twelker, 1967) is an example of the emphasis on the transfer from the instructional situation to the real-life situation, where the role that is being practiced is the learner's own role. The difference between these two emphases may be summarized in the following manner: simulations that are based on the learner "being someone else" may be termed "role-assuming" simulations while techniques that are based on the learner practicing his own future role may be referred to as "role-performing" simulations. Of course, each type of simulation has in common the element of the learner behaving as though he were in a real-life situation.

Note that this conception of contextual response simulation is tied to use, and not necessarily to form. For example, an aircraft simulator may be thought of in terms of contextual response simulation because it is usually used for exercising the pilot in certain required skills. However, it could be considered a referential simulation if it is used simply to demonstrate a control function or to illustrate the placement of controls. In the same way, learning games may be thought of as a criterion response simulation. Yet, it may be a referential simulation for a particular student who observes the game in progress for the purpose of seeing an example of learner-controlled instruction. In a word, the distinction is between a learner as an observer (referential simulation) and a learner as a participant (contextual response simulation). Some have said that noise is not noise, unless it is heard. Similarily, a contextual response simulation is not a contextual response simulation unless participants are engaged in the learning activity. In a very real sense, then, what is being described is a technique, not a model. Instructional simulation is a way to use a model, not necessarily the model in and of itself. Contextual response simulation is more than a series of episodes, or a machine, or a scenario and rules of a game. It is a way of using these things in an instructional system that guarantees involvement of the learner in non-real-life stimulus situations that simulate some aspects of real life.

Museums, in cooperation with local school districts, are beginning to recognize the value in modifying the displays so that the student is a participant in the learning experience rather than simply an observer. For example, typical museum displays, such as a pioneer house, filled with all of the furniture tools and clothes of that period, are shown to students, many times behind a rope or even glass. The student has little opportunity to learn about how life really was in the pioneer days, except vicariously. The modified displays allow children to participate as a frontier man in a "live-in" museum perhaps for several days and live the life of a pioneer in this simulated situation. The student works with the tools of that day, "hunts" food, prepares the fire, chops wood, tends animals, reads books of that day, and wears the clothes that were worn, all within a realistic but controlled environment. Simulation allows the student to move past the barrier that limits his experience to observation, to an experience where participation is possible. In the words of Clark Abt, the learner "is forced to interact with the material in an active way rather than a passive way" (cited in Twelker, Crawford and Wallen, 1967).

Non-real-life Situations

The stimulus may be represented in many forms. It makes little difference as long as consideration is given to the fact that transfer is involved from the instructional situation to real life. Recall that a response is made to some object. The specification of a response includes both the object acted upon and the nature of the response. Performing the task in a non-real-life setting (an enacted response) may be done in the presence of a number of stimulus situations. For example, the response, "Manipulating controls" may be done with a cardboard mock-up placed in front of the student. If the student goes through the motions of operating the controls (pantomiming), he is enacting the response, but to an iconic (pictorial) display. On the other hand, manipulating controls as a response may be accomplished with a model of a real-life control panel. In this case, the student enacts the response to a stimulus display that might be termed "concrete" as compared with "iconic."

Historically, simulation designers have placed a lot of emphasis on the physical appearance of stimulus situations. Designers have often been overly concerned with the realism fidelity of the simulation as an important dimension and have designed simulations that resemble as closely as possible the real situation. This has led to the building of aircraft simulators that duplicate entire cockpits, for example, often for the training of basic skills of aircraft operation which have little or no need of the high fidelity provided.

Gagne (1962) and others have implied that the stimulus dimension is not the only important factor to consider in the design of a simulation. A designer does not start with physical appearance, whether it be a game or a training device. Rather, he concerns himself with the response dimension or what Gagne refers to as "operations" or "tasks" (parts of operations). Operations are defined as interactions between man and machine or between man and his environment. It should be understood that the environment may include other men, and we might specify that type of interaction as well, that is, between man and man. Once the simulation designer knows what operations he wishes to teach or exercise (and conversely, what operations or tasks he does not wish to teach or exercise), he then considers the appropriate means to bring this learning about, and this brings him to the question of how his simulation will look. He does not start with physical appearance, scenarios, or rules of the game in the hope that the operation is taught. Rather, he concerns himself with specifying the operations, and then specifying the conditions - the stimuli, feedback, and context, that will provide a realistic environment for the operations to take place that will bring about a change in the student. In other words, form follows function.

Feedback

The fact that an individual can interact with or participate in a stimulus situation, whether that be composed of man, machine, or a combination of both, suggests the third feature: the instructional technique can present feedback with the respect to the learner's behavior in the ongoing instructional (simulation) context. In real life the individual interacts with another individual, for example, and receives feedback from the individual. Or, the individual interacts with a machine, and receives feedback from the machine, in the general sense of the word. The real-life situation is dynamic as compared with static. For every action there is a reaction from the environment of one sort or another. This feature is provided for in contextual response simulation. For example, in a learning game, peers' reactions to an individual's decision are quick and at times far more effective than a teacher's mark in a gradebook. In fact, some have suggested that learners often may listen to peers more than teachers.

Control

Control must be examined from two points of view: from the instructor's, and from the students'. Looking at control from the instructor's point of view, we find that the real life situation is uncontrolled and subject to unpredictable variation, no matter how well supervised it is or how predictable it has been in the past. Both reproducability and planned variation are crucial characteristics of control in contextual response simulation.

Reproducability. The instructional experience may include provision for the student to repeat the problem and respond in different ways, all the time receiving feedback as to the correctness of the response. For example, in classroom simulation training, students may try out different responses to the same stimulus situation and see probable classroom reaction to their responses by means of feedback films.

Not all types of simulation offer the same amount of control. Shubik (1960) distinguishes between "environment rich" and "environment poor" games, and points out that different games offer more control than others. The type of game used at RAND by Goldhamer and Speier "is relatively unstructured, (and) calls for considerable role playing and for discussion by both the referees and the players as to the validity of the moves" (Shubik, 1960, p. 737). Shubik cites the economic game developed by Siegel and Fouraker (1960) as much more closely controlled.

Cohen (1962) points out that a limitation of learning games to explore aspects of international relationships is the "very great difficulty of replication." He states that it is virtually impossible to replicate a game from day to day or from term to term or from university to university so that all of the many variables involved in the outcome of the game are held constant. Thus it is difficult for a student to play a game, and develop an hypothesis or theoretical proposition about the cause and consequences of policy, and then expect to test that proposition in a replay. Cohen suggests that probably the best that can be done is to use the same scenarios in different plays of the game and then compare the moves and outcomes, but not hope to draw theoretical conclusions about causes and consequences. This caution would also hold for the planned variation of particular conditions for purposes of experimentation.

Since the response is enacted (life-like) and the stimulus situation is not real-life thus offering control, there is little hazard or threat to the welfare of the individual. It has been pointed out that Classroom Simulation (Twelker, 1967) allows the student to react to filmed problems as though he were in a real classroom. The student is not subjected to embarrassment that may result from an inappropriate move on his part. Students are not subjected to inept instruction or management, or embarrassment for that matter from a student teacher who either requires further training or simply wishes to try out various strategies without fear of censure or negative consequences that affect others.

There is a more general consideration of the use of simulation as a substitute for real life. It may be summed in the words, "When learners can't learn about the workings of a legislative body by actually participating in such a body, then simulation is an ideal technique." If an individual can't design a city in real life to learn about some important factors in urban renewal, then use simulation. It if is too expensive to practice the conduct of a small business in real life, then build a computer simulation, and experience bankruptcy painlessly.

Planned Variation. The instructional experiences might also include planned variation of the simulation situation (cf., Gagne, 1965). This often serves to enhance later stages of training and is thought to be an absolute requirement for transfer. In this case, we do not wish to present the same stimulus situation time and time again. By doing so, we would risk a biased training of an individual by limiting his experience to a narrower range than normal. The result of this excessive type of control would be that it would contribute to the learning of the task in the instructional content but detract from the transfer required when the learner must exhibit his newly attained skills in real life under varying stimulus conditions. For example, in classroom simulation training, students are shown a limited number of behavior problems, and are asked to respond to these problems appropriately. If the student perceives the behavior problems as "only the way it happens" in the classroom, he is due for a rude awakening when real life problems actually occur under slightly different circumstances. Control, in terms of reproducability of the exact stimulus, would be useful in training under these conditions, but would produce a negative effect on transfer. Another example would be in the area of counselor training. What problems might be encountered if student counselors were trained with a technique that taught them to respond to a simulated client that behaved in a highly predictable fashion all of the time? The student would certainly be ill-equipped to confront his first real-life patient.

Looking at control from the student's viewpoint, we find that contextual response simulation provides the learner with an experience over which he has some degree of control. For example, in a learning game, the learner is free to behave in whatever way he chooses and to control his "destiny" (more or less) as he sees fit. Of course, there are limits set as to the extent to which the consequences approach real life in the simulation experience. Nevertheless, the opportunity given the learner to vary his behavior in a number of ways, to try out different strategies, and to act out hunches or intuitions, all in an atmosphere that is positive and free, and which provides feedback relevant to the behavior, contributes a great deal to the outcomes of learning.

A growing body of theory and data supports the above statement. Rotter (1966), Seeman (1966) and Coleman et al. (1966) suggest that learning is affected by the student's sense of what is termed their "control of destiny" or "belief in control of environment." This control of destiny is in distince contrast to control by luck or arbitrary features of the learner's environment. Boocock and others (Boocock, et al., 1967) subjected to empirical study the hypothesis that simulation games have a general impact upon this attitudinal variable. This hypothesis was based in part on over five years of experience with field testing simulation games. Although their results were negative in that sense of control of a general sort was not found to be related to simulation game experience, they did find that there seemed to be some development of a sense of control in specific areas of activity. It was quite possible that the measuring instruments used were not sensitive enough to detect changes. For the reader interested in research on control of destiny, the final report by Boocock and others is recommended.

Allow me to summarize the features of contextual response simulation. Contextual response simulation involves enacted (life-like) responses in non-real life settings. These stimulus settings may represent a "simulation continuum" that ranges from very realistic situations to situations that are not at all realistic. Feedback is provided in the ongoing instructional context. These features allow the student to participate in a controlled learning experience which presents little or no hazard to the individual. These characteristics of contextual response simulation are tied to use and not necessarily to form.

The Scope of Contextual Response Simulation

Now that the features of contextual response simulation have been discussed, it should be possible to examine the extent to which several instructional techniques meet the criteria adopted for this type of simulation. What about such techniques as moot courts, mock congresses, case studies, role-playing, socio-drama, academic games, and other related methods. Let us examine these techniques one at a time.

Moot courts and similar experiences. First, a moot court involves students taking the part of attorneys in order to "try" a case. Students have the experience of preparing depositions and briefs to prepare for the "day in court." Clearly, students are involved in performing various real-life tasks but in a non-real-life setting. Students who are involved in the moot court are clearly participants in the learning experience. They practice preparing briefs as though the case were real. They practice delivering the case in front of the judge and peers.

Robinson (1966) maintains that moot courts and related techniques cannot be considered as simulations because the techniques involve more role-playing than simulations. Further,

> "simulations tend to formalize and program various aspects of the systems that they represent; that is to say, they permit less flexibility than do the free-wheeling mass conventions. Simulations concentrate more on the processes by which decisions are taken and devote less attention to the institutionalized and particular procedures of conventions or congresses. They require the participant to engage more in the dynamic interaction of the system and expect less of him in the way of second-guessing or of playing the role of a particular person or position." (1966, p. 95).

Robinson points to the de-emphasis of role-playing, the highlighting of process factors, and the formalizing of programs for the conduct of the simulation, as the main distinctions between simulation and techniques such as moot courts. For this writer, the first point seems questionable in view of the many games now being developed that involve the player in situations for which he has no background. However, the matter of control that the instructional conditions offer is inherent in the other points. Simulations are not entirely free-wheeling. They operate within bounds -- bounds that involve the rules of the game and even the conduct of the game in "rounds." Moot courts are not characterized by control, and the supervision that is posible with such control. When students are preparing briefs, no provision is given to monitor the work. Neither is there any monitoring of student behavior for the purpose of providing feedback in the instructional context. In some ways, the moot courts are parallel techniques to practice teaching where control is minimal.

Psychodrama, sociodrama, and role-playing. At first glance, both psychodrama and sociodrama could be thought of as posessing the characteristics of a contextual response simulation. A closer look reveals that psychodrama is a method of diagnosis and treatment of personality problems, and when used for group therapy becomes sociodrama. Katona (1955) states that "in its original meaning, sociodrama apparently is some sort of social panacea, a means of cure for troubled groups, as psychodrama is a means of cure for individuals." Many individuals have changed the original meaning so that in addition, sociodrama refers to the dramatization of a social problem, an issue or a situation, in order to make it clear so that individuals may better solve the problem and at the same time change their behavior. In any event, it is clear that the goal of psychodrama or sociodrama may be thought of more in terms of therapy than instruction, even though both techniques involve enacted responses. Control is minimal, and the sociodrama or psychodrama is more or less free-wheeling. They should probably be thought of more as techniques related to contextual response simulation.

It is more difficult to dismiss role playing as a type of contextual response simulation. First of all, authorities define the term differently. Some take it to mean the same thing as sociodrama. Others talk of role playing as the depiction of characters in scenes for illustrative purposes in which case it would qualify as referential simulation. For example, an instructor may stage a proper interview approach in a course of training a team of research workers (cf., Katona, 1955). A sociodrama would differ from role-playing in that a group would enact the scene, not the instructor. Others equate role-playing with "let's pretend" or "play-acting" (cf., Garvey, 1967). Grambs, (et al., 1958) defines role playing as "unprepared, unrehearsed dramatization." However, they are quick to point out that the technique of role-playing is mainly concerned with the development of deeper understanding of social relations. For example, a particular social issue may be, "If the United States has a surplus of food, to what country should it go and under what terms?" The authors point out that the teacher may assign some members of the class to various roles of spokesmen of various countries, United States officials and diplomats, and so forth. Each present their point of view, and when the experience is ended, certain concepts were developed about foreign viewpoints.

Chesler and Fox (1966) give the example of a teacher who attempts to solve a problem in interpersonal relations by using role-playing. Two children are asked to take the part of fourth-graders, and two children are asked to take the part of sixth-graders. The plot is simple. The fourth-graders have bent a runner on a sled so it doesn't work. Some sixth-graders appear, each with a new sled. What should they do? The teacher has set the stage for conflict.

In both examples, it should be noted that the majority of the class witnesses the role-playing. Only a few students actually participate. Role-playing is followed by a discussion involving the entire class. Role-playing does not involve simultaneous participation of all class members. Most class members are observers of the depiction of characters. Because of this factor, role-playing is probably best thought of as a technique related to contextual response simulation.

Case Studies. Typically, the case method presents a problem situation from the perspective of the learner. Either complete information that represents all that is available or incomplete information that requires the learner to seek out additional relevant information may be given. The problem situation may be quite lengthy, or it may be quite brief, (for example, the Incident Process as developed by Pigors and Pigors [1961]). Usually, the case is discussed in a group situation with the members participating in seeking solutions to the problem, and relating the problem to other course materials. Foster and Danielian (1966) suggest that "because the case is generally written so that members approach the problem from the perspective of a person in the case, the method may be viewed as a nonbehavioral or passive form of role-playing." The goal of the case method is clearly to bridge the gap between theory and practice through simulated experiences that are encountered in real life. The instructional objectives of the case method, seem rather complex. They do not deal with the acquisition of knowledge as much as the

> "development of the ability to analyze realistic problems and to master the tangle of facts and circumstances that suggest conflictive solutions. Through his involvement the trainee comes to learn that solutions are not as obvious as at first they might appear, that more information is needed than he may initially tend to believe, and that everyone does not perceive the same set of events in what seemed to him to be the obvious way" (Foster and Danielian, 1966).

The interesting thing about the case method is that there are no right answers. Principles that are appropriate in one problem situation may not be appropriate in another. According to Foster and Danielian, "The basic purpose is to learn how to deal with certain types of problems rather than to learn a set of solutions per se." More attention is given to the process of how solutions were arrived at rather than the content of the problem. The case method has been used for some time in law schools and medical schools, and in a wide range of courses such as political science, public administration, management training, research methodology in sociology, and legislative processes (cf., Westin, 1962; Stein, 1952; Tillett, 1963; Const, 1957; Riley, 1963).

Does the case study represent a contextual response simulation? Although overt behaviors commonly associated with learning games or simulators are not present in case studies, the learner is exercised in decision-making and problem solving similar to that required in real life situations. In this sense, the criterion of enacted responses is met, at least in terms of these specific behaviors. The provision of feedback is tenuous at best since no right answers exist, and it is difficult to tell whether the strategy being employed to arrive at a solution is indeed the appropriate one. The Incident Process

(Pigors and Pigors, 1961) is an attempt to systematize the provision of feedback to some extent, but even in this case, it is primarily limited to providing additional information on the case rather than attempting to direct or reinforce the process of decision-making or problem-solving. Of course, the subsequent discussion or critique (debriefing) at the end of the information-gathering period also provides feedback, but here again the emphasis is on what processes affected the decision making rather than on the most appropriate process that would lead to the best decision-making.

Academic Games. Simulation games, educational games, learning games, games with simulated environments, simulations, and simply games, are all terms that describe this technique. Since games are usually thought of in terms of entertainment, often the word, "simulation" is added to make the technique appear more respectable. Yet, a simulation game, in a sense, does entertain by the use of competitive activity among the players. In the well known family game of Monopoly, players compete with each other for properties and the eventual wealth that comes from owning hotels on strategically located places. An example of an extension of this game to business is the American Management Association management-decision course. Abt (1966) defines a game as "any contest (play) among adversaries (players) operating under constraints (rules) for an objective (winning, victory, or pay-off)." Nebsitt (1968) presents a less formal definition: "a game might be defined as something enjoyable -- however serious -- involving competition for specified objectives and observing rules." It is quite possible that games for learning are outgrowths of war games such as chess and similar board games (cf., Weiner, 1959; Young, 1956). Abt (1966) points out that war games "were probably originated by military practitioners for their part-amusement, part training." An officer playing a war game not only is challenged to win, he may, in the process of the game, learn certain military principles. There is little doubt that the wide acceptance of learning games in education today is related to this phenomena of learning something while enjoying it. In an interview with high school students who participated in several games at Clark County, Washington, Instructional Games Workshop, a question was asked of one student, "Did you do more homework than usual to play the game?" The student answered, with a puzzled look, "Gee, I never thought of it as homework!" In short, the learning game proves that instruction need not be boring by actively involving the student in simulations that are relevant to the student's own life. Since most students enjoy games, and receive considerable satisfaction from them, the use of games for academic pursuits is one way to assure student motivation while at the same time teaching.

Are learning games to be considered as contextual response simulations? Clearly, most games involve enacted responses to the non-real life situation. Further, students oftentime receive very quick feedback as to whether or not their responses are effective or ineffective. This feedback usually comes from peers rather than teachers, as was stated above. The matter of control is difficult to assess in learning games. Yet, in comparison with real-life situations, there is enough control in the simulated environment so that the same game may be played time and again with predictable results if proper attention is given to administrative details. Most simulation games can certainly be termed a contextual response simulation. An exception to the rule might be some of the "academic games" developed by the Nova Academic Games Project. Some of these games clearly are not simulations, but simply provide experiences that are competitive in nature.

In-basket technique. The in-basket approach has become widely used in recent years for testing and training administrators in business and education. The materials for instructional purposes have been developed through the University Council for Educational Administration (Frederiksen, Saunders, and Ward, 1957; Frederiksen, 1962; Hemphill, Griffiths and Frederiksen, 1962). The learner's task is to consider various messages that come to him through his in-basket and decide what responses he should make that would be most appropriate. Some items may be delayed or discarded since they are trivial; other items are far more important and require immediate attention. Each communication involved the learner in either searching for information (discussing, investigation, asking opinions and advice from others), or giving information (issuing directives, giving opinions, citing rules, acknowledging events). In some cases, the learner is involved in making enacted responses to non-real life situations. Other times, the learner writes what he would do. The matter of feedback in an in-basket situation is also tenuous. Present techniques are limited in the type and amount of feedback which may be presented to the learner, since all possible unanticipated consequences of a learner's responses have not been specified. Bessent (1967) does describe a feedback sequence for the requesting information mode that utilizes a computer-assisted format. The author concludes that no major problems exist with the feedback procedures as long as the learner is searching for information. When the learner is given information, limitations are encountered. However, the feedback procedure described by Bessent offers a promising approach to the extension of the in-basket technique.

Classroom Simulation. The technique of Classroom Simulation as developed at Teaching Research has been cited as an example of a simulation used to elicit life-like responses. Indeed, the prototype situation is clearly an example of a contextual response simulation. It is important to realize, however, that variations in the classroom simulation technique may remove it from the arena of contextual response simulation. For example, in one mode that has been developed with new "low-cost" materials, a student sits at a study carrel and writes out her answers after covertly responding to a filmed episode. Clearly, a covert response is not an enacted response, that is, a life-like response performed in a non-real life situation. Yet, all of the other features of the simulation are similar to the original Classroom Simulation.

The educational techniques that have been discussed above show the difficulty of positively stating that one thing is a "contextual response simulation" and another is not. There are clear cases where a technique fits the definition. Other cases are questionable. The criteria for labeling a technique a contextual response simulation, and several examples of classification are presented in Figure 2. The question marks in Figure 2 reveal cases where the criteria is unclear without specification of the instructional conditions by the user.

Two Crucial Considerations

Transfer

Transfer is a term that is almost as difficult to define as the term simulation. In its conventional usage, transfer occurs whenever a previously learned skill or habit or behavior influences the acquisition, performance, or relearning of another skill at a later time. When performance on the second task (the "transfer task") is facilitated, it is said that "positive transfer" has occurred. When performance on the second task is inhibited, it is said that "negative transfer" has occurred.

Gagne (1965) talks about two types of transfer. One type makes it possible for the individual to perform in a way that is not directly learned, but is in some sense similar to what was learned. Consider a population of situations, all of which represent only one class in terms of the operations involved. For example, imagine a population of cryptograms, all of which are different in terms of the symbols used, but which could be solved by applying the same rule or principle. Or consider a population of toggle switches, all of which require the same movement to activate a machine. In terms of this type of transfer, a "one-to-many" relationship is involved: one operation pertains to many situations. Gagne terms this type of transfer "lateral transfer," since it refers to a kind of generalizing over a broad class of situations at about the same level of complexity.

A second type of transfer Gagne terms "vertical transfer," which involves the application of subordinate principles previously learned to the learning of additional principles at higher levels. The key to satisfactory vertical transfer is the mastery of the subordinate principles or capabilities.

Technique Characteristic	Instructional Films	Models	Simulator-(Trainers (e.g., Link Trainer)	Classroom Simulation (Prototype Mode)	Case Method	In-basket Technique	Non-simulation Games (e.g., Wff'n'Proof	Simulation Games	Sociodrama Psychodrama	Role-Playing	Moot Court and Similar Experiences
1. Enacted response is involved.	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	For Some Students	Yes
2. Non-real life stimulus situations are involved.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Feedback is provided in an ongoing instructional context.	No	No	Yes	Yes	No	?	Yes	Yes	?	?	Yes
4. Control: reproducability and planned variation are possible (within limits).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Control: learner has some degree of control over the experience.	No	No	Yes	Yes	?	Yes	Yes	Yes	Yes	Yes	Yes

Figure 2. Classification of various instructional techniques in terms of characteristics of contextual response simulation.

It would seem appropriate, when considering simulation, to think in terms of a third type of transfer that might be termed "horizontal" or "parallel" transfer. This involves the transfer from the instructional conditions to the testing of transfer conditions when the situation and operation required in the second task is equivalent to that taught previously. That is, the operation required in the transfer situation, which may be a real-life situation, by the way, differs from that taught in the instructional situation only in terms of what might be called a simulation continuum. For example, if the instructional conditions used an iconic situation and involved enacted responses, the transfer situation might also involve the same modes. In this case, no parallel transfer would be required since the transfer conditions and the instructional conditions were essentially equivalent. On the other hand, if the transfer condition involved the real-life situation (and hence a real-life operation) then parallel transfer would be involved since the subject was instructed under different conditions (that used simulation). Also, if the transfer situation were a paper-and-pencil test, parallel transfer would be involved since the subject must then transfer from the enacted response to the symbolic response and from the iconic stimulus to perhaps a symbolic stimulus. In short, parallel transfer involves the learner in simply moving from the instructional situation to a parallel transfer situation which involves the same situation, and the same operation. The only difference is that when the skills or knowledge were learned, the conditions were different than when the subject was tested.

The characteristics of the three types of transfer, lateral, vertical, and parallel, are summarized in the figure below.

Type of Transfer	Situation	Operation	Characteristic
"Parallel"	Informationally Equivalent	Operationally Equivalent	S applies same operation to same situation in the transfer condition as in instructional condition. Testing condition may be more or less realistic.
"Lateral"	Member of Class of Situations	Operationally Equivalent	S applies some operation to members of a class of situations.
"Vertical"	Member of new Class of Situations	Different	S generates new operation from previously learned operations.

Figure 3. Testing (transfer) task as compared with instructional task.

Now it is not too difficult to see how the consideration of parallel transfer is important when a role-performing simulation exercise is developed. A prime objective of such a simulation is to have the learner operate as though he were in a real-life situation so that he will perform in the real-life situation adequately. This is true of complex aircraft simulators, some in-basket techniques, and probably certain learning games where the role that is played is the same as that to be performed in real life.

It is more difficult to see how the consideration of parallel transfer is relevant to the design of role-assuming simulations that characterize many learning games. However, recall that the characteristic of parallel transfer is that the learner applies the same operation to the same situation in the transfer condition (which may be real life) as in the instructional condition. For example, an administrator is taught to make decisions in an in-basket technique, and these skills are meant to transfer to real life. That is the point of the simulation exercise, and in fact, is inherent in role-performing simulations. Now, when roles are assumed in an academic game such as a foreign policy game, the learner or role-player is usually uninformed, as Cohen (1962, p. 374) points out, and possibly too inexperienced or culture-bound to play the part of a leader of a foreign nation, for example. It can be seen that in this situation, there may be little more that the student can do than merely play the role on hunches and intuition. The implication in terms of parallel transfer, is that the learner may be applying different operations to somewhat similar situations in the instructional condition as would be the case in the transfer (and possibly real-life) condition, the difference depending to a great extent on the prior knowledge he has of the role that is essential to the playing of the role. This condition has led some writers, such as Kraft (1967) to argue strongly against learning games as being non-realistic because the operations performed in the game, e.g., a two-minute "negotiation" in a legislative game, are not typical or representative of real life, in terms of the actual complexities in real life. Bloomfield and Padelford (1959) indicate that some game members found their roles in a political game difficult to play. Cohen points out that most students, graduate as well as undergraduate, suffer from a "knowledge gap" which prevents them from playing the role of a real-life counterpart. Further, Cohen states that

> "even if a player knows the role he is playing, about the objective foreign-policy situation, and about the political environment of policy-making - which are all unlikely contingencies - the probability that he will behave in a manner that is indicated by that role is rather low" 1967, p. 376).

It can be seen that parallel transfer not only involves performance _in_ an operational situation, it involves knowledge of facts, principles or relationships _of_ an operational situation. Supposedly, what is taught in instruction must fit real life. If there exists a "credibility gap" between instruction and the operational world, then the learner is at a disadvantage when it comes to either performing in the real world, or understanding what the real world is like.

This writer once played a non-computerized business game where the team made a set of decisions and recorded them on a form that was sent to analysts. The analysts were responsible for returning information that spelled out the consequences of the decisions made by the team. This sequence was repeated for several periods. It quickly became evident to the teams that something was amiss in the running of the game when actions and consequences didn't make any sense. Two teams might decide on similar courses of action, but one would be rewarded with sales while the other would be profitless. The teams soon learned that the reason for this was that the analysts tossed a coin to decide the fate of the companies. The model was inadequate to cope with the complex factors of the game, and chance was allowed to play a major role rather than a minor role in the specification of consequences. A "creditability gap" existed between the real world and the game that simulated the real world. It existed to such an extent that participants could not predict what business moves led to what outcomes since the probability was 50-50 that the outcome would be negated by the toss of the coin. What is taught in this type of game is probably minimal. Cohen and Rhenman (1961) quote Martin Shubik at a national conference on management games whose remarks are pertinent here:

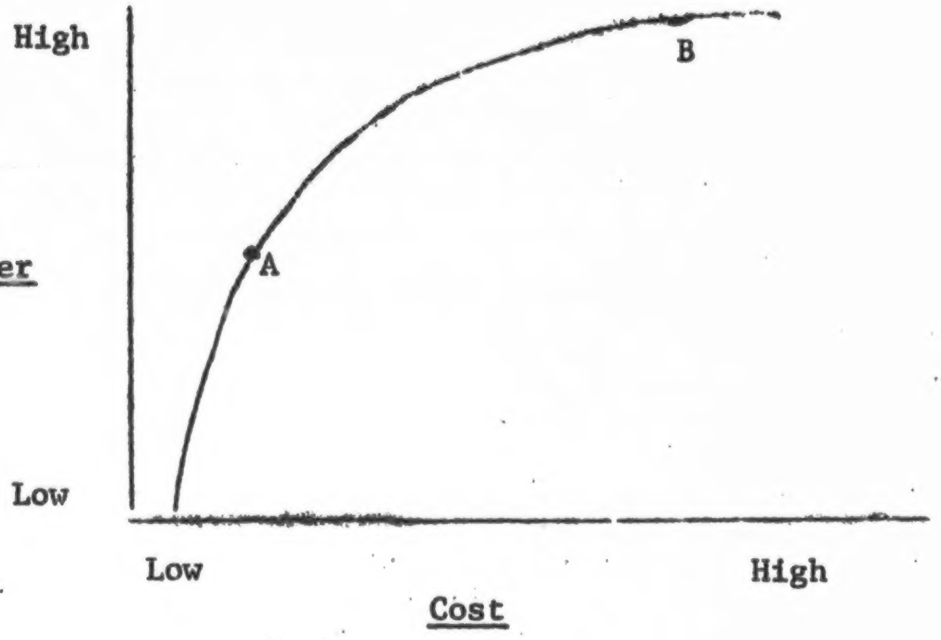
> "I wonder if the speakers who have spoken so far have actually had any specific purpose in mind. Have you gentlemen had one or two general hypotheses? Do you have any specific purpose other than that everybody has a whale of a time in playing these games?"

It behooves the designer of simulations to at least consider the factor of parallel transfer. The designer must assure the student of learning the same operation or the same facts that are applied or used by others in real life. Otherwise, that learner is at a disadvantage when it comes to understanding the real life world. Now this caution is not limited to role-assuming simulations. It is conceivable that in role-performing simulations, the student does not have the appropriate entry behaviors necessary to perform in the simulation as though it were real life. This may have been a drawback of the original classroom simulator as developed at Teaching Research (Kersh, 1963a; 1963b; 1965; Twelker, 1967). Students didn't have the necessary knowledge initially to handle the many problematic situations, and the technique was unable to draw these behaviors out of the student except through a tedious question-and-answer session. The simulation did not _exercise_ previously learned principles of classroom management, but taught the principles through a discovery process. As a result, training time was excessive for many students. The new instructional simulation materials developed at Teaching Research teach some basic principles of classroom management directly, and then exercise the student in the application of these same principles. Without this two-step process, it could not be assumed that the operations that were being applied during instruction would transfer to real life.

One curcial question in regard to transfer is: Does exact physical duplication of the stimulus and feedback situations guarantee maximum positive transfer? The research literature does not have a precise answer to this question. On the one hand, older studies on transfer of training have shown that the more similar two situations are the more transfer will occur from the first situation to the second situation. For example, Bugelski concludes that "...experimental findings indicate that positive transfer is a function of the degree of similarity between stimuli (if responses are the same)" (1956, p. 408). As a result, we have seen an abundance of so-called "high-fidelity simulations," some of which are so complex that entire teams of operators are required to monitor the experience. On the other hand, later studies have placed doubt on the maxim, "For maximum transfer of training, use perfect fidelity or realism." There is some evidence to indicate that for complex skills, greater transfer is produced by a systematic arrangement of practice than by high-fidelity physical simulation (Gagne, 1962; Cox et al., 1963; Gryde, 1966; Crawford, 1962; Smode, 1963; Newton, 1959). In fact, for tasks of high difficulty, it is probably more advantageous to use simulation to simplify the instructional conditions as it is to use a real life situation in hopes to increase positive transfer. By using simulation, time may be compressed or expanded, feedback may be augmented, emergencies may be introduced, guidance may be used to limit learner errors, task variety may be introduced (as an aid to lateral transfer), and practice may be distributed (cf., Smode, 1963, p. 97-98).

Unfortunately, even if a simulation designer did know how to design the system for maximum positive transfer other factors must be considered. For example, the designer must consider trade-offs bet between transfer and cost, primarily. Further, trade-offs between transfer and safety, special training, provisions for feedback, must also be considered.

The trade-offs between transfer and cost or economy is illustrated in the figure below. The curve shown is a hypothetical relationship between amount of transfer and cost of a simulation. Point A illustrates a trade-off between providing for a medium amount of transfer at a relatively low cost. If economy is not an important factor, the designer may choose to accept a high cost-high transfer relationship as shown as Point B.



It should be made clear that this discussion has not attempted to define either cost, or the way that transfer is measured. These are problems that must be worked out by the simulation designer. Suffice it to say, there is no easy way to define cost, since it may involve cost per student hour, cost per unit to produce, cost per unit to sell, and so forth.

In summary, it should be realized that exact physical duplication does not guarantee maximum positive transfer. Recall that Gagne insists that the most important thing is to determine the operation to be taught, and then specify the conditions to bring about the learning of that operation so that the student will perform in the real life situation satisfactorily. Muckler, et al. (1959) also points out that transfer will be greatest when there is psychological fidelity, that is, when the skills taught in the simulation experience are the same as in the real-life situation. For a more complete overview of the state of the art in regards to transfer and simulation design, the reader is directed to discussions by Miller (1953), Gagne (1962), and Gryde (1966).

Motivation

Another factor that seems to lie at the heart of simulation is motivation. Sprague and Shirts (1966) states that the involvement of students in learning games causes inquiry and discussion after the simulation. Abt (1967) cites increased student motivation as one of two primary "pay-offs" with education games and simulations. Cherryholmes (1966) reviewed six investigations of educational simulations and concluded that simulation produced increased student motivation and interest. Walter Cronkite, in a CBS documentary suggested that "by participating by playing a game, an otherwise dull subject becomes fascinating and unforgettable to the students."

Why is simulation motivating? Clark Abt suggests that the reason is that there is increased student motivation because subjects of topical relevance to the student's own life are selected and because students actively participate in the simulation. He adds the following insights:

> "A great deal of our substantive content is not perceived by the student as relevant to his own life, however much we might feel that it is and should be so perceived. A great deal of the material, whether perceived as relevant or not, is not actively responded to by the student. We would like to introduce the active response mode that has been so successful in the area of the physical sciences into the social studies area. We would like to introduce essentially a laboratory method, and we would like to do this with material that is perceived as substantially relevant to the student's own life. We believe the educational games and simulations achieve this objective, of giving the student a feeling of the relevance of the material to his own life and of enticing him into active engagement with the material." (Cited in Twelker, Crawford, and Wallen, 1967.)

Smode et al., (1963, p. 99) introduces the term, "motivational similarity," as that which is concerned with the feeling or attitude of the learner in a simulation experience as compared with a feeling experienced in real life. Smode's orientation is principally that of a military trainer of aircraft operations. As such, a primary factor in motivational similarity is the realism of the simulation. It is conceivable that a simulation might be designed that would produce optimal transfer except for the fact that its lack of realism causes the learner to disregard the instructional experience because of its obvious falsity. If lack of motivation results, then measures must be taken to assure the proper conditions for instruction to be effective. To this end, physical similarity must be added to the two factors of relevance and activity mentioned by Abt. It goes without saying that this does not contradict the emphasis given by Gagne to the specifying of operations to be taught before physical conditions of realism are considered. It does point up the fact that even though operations are the crucial thing in designing simulations, the stimulus and feedback situations must not be ignored lest the conditions be inadequate for eliciting the desired responses on the part of the learner.

One word of caution must be given when considering the physical similarity of a simulation, and this is relevant in designing a learning game as well as a complex simulator. The design of simulations is often times influenced by a desire to make them "more appealing" and "interesting" to learners and this usually takes the form of increased realism of non-essential elements. If properly done, it adds to the effectiveness of a simulation. It motivates the student, and he regards the experience as meaningful and relevant. On the other hand, simulation designers often resort to "gimmicks" or what Lumsdaine refers to "fancying up" the device or technique which may cause distractions that may "interfere with the attention of the student to the essential task to be learned, and thus have an adverse effect on learning rather than a beneficial one" (Lumsdaine, 1960, p. 283).

Smode points out that motivational similarity is a function of the entire instructional program. Thus a fourth factor emerges: administrative or management considerations of instruction. The way in which the simulation experience is scheduled, the way in which the experience is utilized, the quality of the instructor, the "set" given to the students by the instructor, the "debriefing," and the development of the syllabus all affect motivation. For example, research has shown that the size of the playing group stands out as a crucial variable in the differential effectiveness of a learning game (Inbar, 1966; Vinacke, 1968; Cohen, 1962). Inbar's research led to the following conclusion:

> "In overcrowded groups the players learn the rules of the games less efficiently, interact less, are less interested in the session and participate less actively in it; as a consequence they tend to play a lesser number of moves and the impact of the game is weaker" (Inbar, 1966, p. 26).

In the Disaster Game, Inbar found that nine was the breaking point, but it should not be inferred that this number holds for every type of learner and game. Cohen (1962) points out in a foreign policy game, the size of the class had an important bearing on the size and composition of a particular team, which in turn affected the play: a large team produced lethargic play, and affected the game adversely. Further Vinacke (1968) studied the negotiations and decisions made in a politics game, and reported that size of group was a chief factor in several respects. As size increased,

(1) messages contained less definite offers;

(2) conferences were larger; and

(3) coalitions tended to "overshoot" the minimum required.

In addition, Vinacke (1968) found strong sex differences in his research. Male groups wrote more definite and relevant messages, held more conferences, less often produced a unanimous vote, more often elected the strongest member, and established more disproportionate deals. Male groups also formed minimum coalitions and never reached altruistic coalitions. As size increased, males became more exploitative than females.

Unfortunately, the simulation designer has a meager empirical basis that would aid him as he designs simulation games. A glance at the host of game variables (see Appendix A) which must be considered will reveal the lack of principles to guide the designer in specifying the optimal contextual conditions, such as team size and composition (e.g., homogeneous vs. heterogeneous sex and ability grouping), that provide the greatest learning or affective outcomes. Further, little is known about the advantages and disadvantages of operating in a team as compared with operating singly in a game. Should younger students operate in a team rather than being placed on their own? Should underachievers operate in a team or on their own? Answers to these questions and literally scores of others must be found.

Another very interesting finding by Inbar was that the first few minutes which preceded the beginning of play is of utmost importance for the inducing of interest and participation in the game. Some twenty per cent of the explained impact of the game was accounted for by activities in these few pre-game moments when the rules of the game were read and discussed.

Parker and Downs (1961, p. 34) present other evidence that points to the importance of pre-simulation activities in the context of a flight simulator. They cite an unpublished study by Solarz et al. (1953) where one group of students were told how the differences in fidelity between the simulator and the operational aircraft made the trainer practically worthless. Another group of students were told that these differences existed but were of negligible importance in the value of the experience. Thus, the "set" given to the two groups of students differed, and in fact, an attitude scale showed that the groups' acceptance of the simulator was indeed quite different. In actual performance on the aircraft, however, the negative attitude and the positive attitude groups performed equally. But, the negative attitude group required more trials to criterion and hence more training time. While lack of simulator acceptance lengthened training time, it has little effect on parallel transfer from the instructional situation to real life.

Now it is difficult to speculate on the implications of the study to the conduct of simulations. Muckler (1959) points out that the pilots were highly motivated to perform at a very high level of competency and this motivation may have overridden any decrements from the negative attitudes toward the simulator. It would be interesting to repeat the study with different classes of students some of which were highly motivated in the general sense to succeed, and some of which were potential dropouts. In this case, the factor of set may be shown to be quite important for transfer performance as well as instructional performance. In any event, the evidence presented by both Inbar and Solarz is but an indication of the importance of attending to pre- and post-simulation details. This writer suggests that a manual for a contextual response simulation should include the specification of these activities as precisely as those that are commonly thought of as the simulation experience itself. In fact, Cohen (1962) suggests that physical layouts, and even the weather may affect game play, often adversely. Bloomfield and Padelford (1959, p. 1111) suggest that too close a proximity of teams in a game may deter or complicate role-playing and the maintenance of adequate security, and may unrealistically speed up the dimensions of time. Certainly, careful attention must be shown for all of the administrative considerations of conducting a simulation.

Unfortunately, little research is available that would help the simulation designer specify the activities that precede or follow the simulation exercise. Usually, prerequisite knowledges or skills are required to play the game. How best are these taught? Should they be taught before the game or during a trial run of the game? Further, post-simulation exercise activities, sometimes referred to as debriefing, are crucial to achieving stated outcomes. Yet, little is available to the consumer or designer of simulation exercises that would aid him. All too often, the debriefing ends up as a lecture to the students of how they behaved during the exercise, rather than an opportunity for the student to review for himself what happened, why did it happen, and what alternative strategies or moves might have been made.

A fifth factor that should be mentioned in regard to motivation is that of stress. Stress was mentioned above as an important contextual variable. The learners' perception of stress may make the difference between his perception of simulation as relevant and realistic or irrelevant and unrealistic. It goes without saying that a characteristic of learning games is the amount of stress that is placed on the student to perform, sometimes in difficult circumstances under limited periods of time.

Stress may be produced in the instructional simulation in several ways. First, learner overloading may produce stressful performance. The learner may be overloaded by presenting him with too much information that demands him to make an excessive number of responses or decisions in a given period of time. The rate at which a learner may receive information is dependent upon the input difficulty, learner ability, and rate at which the input is presented. For example, a learning game involving a political emergency may be designed to produce stress by simply increasing the number of messages to the participants that in turn require them to make an excessive number of responses in a given amount of time. Whether or not the instructor wishes to do this is dependent upon his objectives. If the instructor's objective is to exercise the students in making quick decisions under adverse situations, such techniques of learner overloading to produce stress may be used. It should be noted, however, that research has not revealed the optimal level of information overloading for various cognitive or affective outcomes. Neither has research shown whether or not games should be designed to purposefully provide players with more information than they can use.

A second way that stress is produced is the opposite of learner overloading. That is, the learner is "underloaded" so that stimulus input and response outputs are few and far between. Such sensory deprivation produced monotony and under conditions of confinement and isolation, stress, where performance definitely tends to break down.

A third way that stress may be generated is by means of unexpected stimuli and emergencies. These situations require immediate attention over and above that required in the normal functioning of the simulation experience. It is interesting to note that even the threat of such unexpected stimuli or emergencies is often times enough to produce the behavior characterized by stress. It is also interesting to note that a certain amount of this type of "pressure" seems to be necessary for learning to occur, especially when the learning situations are not complex.

It is a different story when complex learning situations are involved. Under such conditions, stress may produce errors, time lag, learner rigidity and other behaviors characteristic of non-adaption. A phenomenon called habit regression may occur when older responses that have no use to the individual and presumably have been extinguished may reappear.

A fourth way that stress may be generated is by the emphasis on competition, either with peers or with a predetermined standard of performance. For example, in a typical simulation game, teams compete with each other for the most points, or for the largest share of the profit. In a simulator-trainer, individuals compete against standards of performance. In either case, stress may be heightened by emphasizing this competitive element. How much competition should be built into simulation exercises is not readily apparent. It has been noted that with some populations of learners, competition that is built into the learning game is deemphasized by the learners. In a language game series developed at Teaching Research, it has been observed that Mexican-American youngsters help each other so that everyone wins, while other youngsters compete in the usual way. Research should be initiated to discover for what types of target populations and learning functions should competition be encouraged or discouraged. Further, research should be initiated to determine how much and what kind of reward should operate in a simulation exercise.

The interaction of some of the factors involved in motivation with the success of the instructional experience is illustrated by Smode (1963, p. 118). He describes a situation where an aircraft simulator resembled quite closely the operational aircraft in function. However, students perceived it as being unrealistic because it was too unstable and hence more difficult to fly than the real aircraft. Tests showed this to be false, and pointed up the problem as one of motivation. Students did not give their undivided attention to "flying" the simulator as they would have in a real aircraft. A momentary lapse of attention caused the student to "get behind" the craft and cause it to go into instability. Such lapses occurred in the simulation experience because motivation was low. These lapses would not occur in the real life aircraft because motivation was high. So what was blamed as a problem of faulty dynamic simulation was actually due to faulty motivational similarity.

What's the Use of Contextual Response Simulation?

Why use contextual response simulation? What does the learner gain by participating in such a simulation? If there are certain benefits or "pay-offs," then how can an instructor in biology or history or psychology, for example, realize these benefits in his own courses. Are some training functions better served through simulation than other training functions?

One problem that is faced in answering this question is the great variety of simulations available. One would not expect that benefits derived from the appropriate use of learning games or other "role-assuming" techniques to necessarily be valid for skills training or role-performing techniques. For example, a primary objective of games as educational devices, according to Schild (1966) is to have the student learn "strategies and skills conducive to winning the game." This benefit probably is limited to certain games and is not appropriately thought of as a benefit of other games or role-performing simulations such as the Classroom Simulation as developed at Teaching Research.

A second problem that is apparent when attempting to identify the use of simulation is that a particular benefit may or may not be realized in a particular simulation, depending on factors such as game administration, learner abilities and characteristics ("entry behavior"), and even instructor incompetence (cf., Inbar, 1966, p. 26). In other words, games may teach winning strategies but only if they are constructed and administered with this objective in mind. The playing of a game does not automatically insure the learning of winning strategies, just as the reading of a book does not necessarily insure the acquisition of facts.

This is dramatically illustrated by Inbar (1966) whose research reveals that "inducing interest in the simulation and enhancing willingness to participate voluntarily in the session are probably the variables which are the most readily influenced by the person in charge of presenting the game." Inbar concludes on the basis of this and other evidence that "the person in charge of the session is of tremendous importance, at least for games which are not readily self-taught and/or self-administered."

With these problems in mind, let us turn our attention to some of the learning outcomes that may be achieved through the use of simulation. It should be recognized that in many cases, little or no evidence is available to support what amounts to intuitive hunches. It should also be noted that examples are given for illustrative purposes only and are not meant to be inclusive of all simulations that may be used for a particular training function. Finally, only a representative number of training functions are discussed.

What may be Learned from Simulations?

Winning Strategies. It was mentioned above that winning strategies may be taught through games. In fact, Schild (1966) suggests that "the learning of strategies has in a sense priority over other possible learning" and is where "the game is likely to have the strongest impact." Research on the Disaster Game by Inbar (1966) reveals that strategies are learned in addition to the problems involved in the simulated situation. Boocock (1966) found that players of the Legislative Game "do acquire strategic sophistication" from the game. About three quarters of the students answered correctly the question of what they thought the most effective strategies were for doing well in the game. Unfortunately, neither Inbar or Boocock present data to show that the students applied the winning strategies, in fact, to win the game. Further, this writer suspects that few games are designed with this objective explicitly in mind. Often, individuals are kept from learning the strategy in games of entertainment to "load the dice" against a naive player's winning and this attitude may prevail in games of learning. Of course in some games, the winning strategies are unknown or at best speculative.

It is interesting to note that the learning of winning strategies is not always paid attention to by evaluators of learning games. Cherryholmes (1966), in his review of current research on the effectiveness of educational simulations, does not list the learning of strategies among the five outcomes he studied. Western Behavioral Science Institute (1966) fails to mention the learning of winning strategies in their list of "hunches" about the uses of simulation. Bloomfield and Padelford (1959) indicate that skills, at devising optimal strategies could be scored in the games they conducted in the area of political science, but were not.

Principles and Relationships. The use of the term "learning game" implies that something is learned. Abt (1966) clearly states that the objectives of learning games are "to educate, not to entertain." Many games, according to Abt, offer "the greatest educational potential for student comprehension of structural relationships (and) the problems, motives, and methods of others." For example, the game of Seal Hunting teaches about the interaction between seal and Eskimo in a hunt. The game of Hunting involves students in learning facts about the primitive social organization and ecology of the Bushman in the Kalahari Desert. Empire is concerned with the 18th century British Empire and exposes students to factual information such as the trade laws, the London monopoly, prices and tariffs. The legislative game developed at Johns Hopkins University (Coleman, 1966) is designed to teach "the basic structure of representative government."

Cherryholmes (1966) reviewed findings from six simulation studies to assess the hypothesis that "students participating in a simulation will learn more facts and principles of information than by studying in a more conventional manner." Without exception, none of the six studies presented evidence to support the hypotheses. Cherryholmes notes that Garvey and Seiler (1966) found that the control group who received lectures and discussion in lieu of simulation actually performed better on the tests designed to measure acquisition and retention of factual and conceptual knowledge. However, examination of these data reveal that none of the differences were statistically significant. It also should be noted that the above-mentioned evidence does not indicate that learning games do not teach, but simply that they do not teach better than other types of instruction. The question that arises, of course is whether or not the time it takes to play a game is offset by other benefits gained from games that are not found with other instructional techniques, e.g., increased interest in the subject matter.

It is probably true that, in general, the acquisition of cognitive knowledge is probably not simulation's best use. Simulation may not be less effective than other techniques, but it may be time-consuming, at least for most applications. One exception to this rule seems to be the computer-based economic games for sixth graders as developed by the Board of Cooperative Educational Services (BOCES) in Northern Westchester County, New York. Wing (1968, p. 162) reports that students "attained approximately the same amount of learning with considerably less investment of time." He concluded that games appeared superior to conventional classroom teaching. It should be noted, however, that the games were computer based, and not of the more common role-playing type.

The learning of factual knowledge (e.g., the meaning of words and symbols, rules and principles, and relationships) is considered by some as a secondary training function of simulators. Demaree defines a simulator as "a relatively complex item of equipment utilizing primarily electronic and mechanical means to functionally reproduce operational conditions to the extent necessary to accomplish the operational mission of an individual or aircraft." Parker and Downs (1961) list the understanding of principles and relationships as a quite appropriate use of a simulator granted it is programmed properly. It should be noted that the use of a highly complex and costly simulator for learning conceptual information may not at all imply that it is the best way to use such a piece of equipment. In many cases, an instructional film or even a chart may teach a principle as well as a complex simulator and at a much less expensive cost. Gagne (1962) points out that the optimal function of a simulation is in the later stages of training, not in the early stages when the learning of prerequisite knowledge is probably most important.

Decision-making Skills. One of Western Behavioral Sciences Institute's (1966) "hunches" about simulation games is that their "primary value is that they teach students how to be more skillful decision-makers." The reason given for this is because students are required in a game to make frequent decisions under pressure, and "they seem to increase their ability to do this within a few hours time.

One of the objectives of most management games is to increase the capability of students to make decisions (e.g., Cohen and Rhenman, 1961; Fulmer, 1963; Dill, 1961). Peter Winters (reported in Twelker, Crawford, and Wallen, 1967) describes a special purpose game for use in a course called Production Management, where students are required to make forty-eight decisions in each of several periods. The unique feature of this game is that the decisions are made or stated by writing a computer program so that the student must be quite specific about his policies. In fact, Winters looks upon this experience "not so much as a game as more research with decision-making."

Demaree (1961) points out that complex decision-making mission-oriented decisions under real time simulation of instrument readings is probably best trained by exercising these behaviors in a life-like setting where the learner may receive immediate feedback as to the adequacy of his response. Parker and Downs (1961) also report that a simulator that includes all of the necessary cues and occasions for the training of decision making is useful if it is properly programmed. As noted above, these writers think of simulators primarily as aircraft trainers. This writer has also noted that increased decision-making skills may be one benefit of classroom simulation training. Students may make decisions about how to handle typical classroom problems, often weighing the consequences of one response against the other (Twelker, 1967). Several studies have shown a definite improvement in the student's handling of the problems after training, as measured by the presenting of novel filmed episodes. Little evidence is available to show that this decision-making skill is transferred to real-life situations.

In the review of the six game evaluation-studies, Cherryholmes concludes that simulation games do not cause students to acquire more decision-making skills than conventional classroom activities. Although Garvey and Seiler (1966) reported that, in one instance, the control group performed significantly better than the experimental (simulation) group, Cherryholmes rejects this evidence as does Garvey and Seiler, on the basis that "the results across group and schools were not consistent or large enough." Although this writer hesitates to relegate statistically significant differences to the realm of sampling error, without at least considering other alternative hypotheses, it is nevertheless clear that games are probably no worse or no better for exercising decision-making skills. It should be noted that Garvey and Seiler did not attempt to measure the quality and speed of decision-making in the game itself. If games did teach decision-making, gains might be noted over a series of games.

Identifications. An important skill that may be taught by the use of contextual response simulation is the learning to identify important cues, signals, and other stimulus situations. Parker and Downs (1961) define "learning identifications" as the "pointing to or locating objects and locations, naming them, or identifying what goes with what -- either physically or in words or symbols." Demaree places the learning of perceptual identifications, and naming and locating as a secondary training function of simulators, which essentially means that a simulator may be used for such purposes, but it may not necessarily represent the most economical approach to this training. This opinion reflects the narrow meaning that Demaree, and Parker and Downs for that matter, attach to "simulators."

It should be pointed out that the identification of cue patterns may certainly be taught by other than contextual response simulation. A chart (a referential simulation) may be quite adequate for teaching a student to identify, for example, various varieties of resistors. However, when this skill must be used in the operational situation, and all sorts of "noise" is likely to be encountered in the system, a simulator may be useful in exercising the learner in his discrimination skills in the operational situations. It is one thing for a novice to "read" Morse code in the classroom. It is quite a different thing to require that individual to perform when unusual messages are presented during various disturbances that may occur on the battlefield. (cf., Miller, 1962).

Procedural Sequences. Parker and Downs (1961) suggest that this training function represents the most effective use of a typical simulator. They point out that it is especially effective in the training of the emergency procedures where practice on the simulator may bring the learner to a high state of proficiency. Demaree (1961) also lists the procedural sequences as a primary function of simulators. However, the term, "integrated task performances" is used rather than procedural sequences. No evidence is presented in either report that would serve to substantiate the use of a simulator rather than other techniques.

Skilled Perceptual-Motor Acts. A discussion of learning outcomes would not be complete without the inclusion of this training function. By and large, the two most widely used applications would be (simulated) aircraft flying and automobile driving. There is some data to show that gains do result from the use of simulation, although not necessarily in increased proficiency. For example, Flexman, Townsend, and Ornstein (1954) report that students trained in an aircraft simulator received thirty hours less flying time than a non-simulator group, but proficiency was equal to or better than the non-simulator trained group. Thirty hours flying time represents a substantial savings in money with no appreciable decrease in effectiveness. The authors do point out, however, that the simulator was better suited for training certain maneuvers heavily loaded with procedural components. This limitation could have been a function of the particular simulator and training program.

The brief examination of the training functions above serve to illustrate the great need for research to determine what type of simulation is most appropriate for the various learning functions. In Chapter III, various guidelines have been specified concerning the rationale for using different types of simulation on given occasions. These guidelines should be tested empirically through a systematic program of research.

In Conclusion

In one sense, simulation does not represent as much a tangible thing or process as it does a philosophy. This philosophy is best thought of as a fusion of two worlds -- the instructional world and the real-life world. In the instructional world, the overpowering tendency for the instructor is to present information, this information often being piled upon the student in illogical sequence and overabundance. Little regard is given to the student in terms of the real-life world. Yet, Fitzgerald states that:

> "the task of intelligence is more than that of a warehouse employee picking stock down the aisles, more than that of the novitiate reciting a long catechism of correct answers, Learning is also insight, inquiry, emergence, the development of any critical faculty, and an intuition of a web of interdependent hypotheses and influences, the structure of abstractions about the seen and unseen, that comprise our

> understanding of the physical world. Learning is also exploring, conceptualizing, experimenting, interacting and valuing" (Fitzgerald, 1962, p. 247-256).

Schwab (1961) adds that the aim of a completely enquiring classroom

> "is not only the clarification and inculcation of a body of knowledge but the encouragement and guidance of a process of discovery on the part of the student. For the student, this means relinquishment of habits of passivity, docile learning and dependence on teacher and textbook, in favor of an active learning in which lecture and textbook are challenged."

Unfortunately, the student is all too often faced with a gnawing feeling that the educational establishment gives inadequate preparation for his vocation whether it be brick layer or politician. This is a feeling that is expressed by those who persevere to graduation. We need not remind ourselves that some do not make it to graduation. Approximately 29% of the nation's potential 'class of 65' withdrew from school between fifth grade and high school graduation," stated the May 1967 issue of the NEA Research Bulletin. Over half of those who start in college do not finish. Some blame the school of failing to stimulate the student. Whatever the reason, it can be easily recognized that one significant thing educators can do is to adopt the philosophy of simulation - that is, to think in terms of bridging the gap between theory and practice - between textbook learning and vocational performance.

The philosophy of simulation also implies that attention should be given to making the learner a participant in a realistic learning experience rather than an observer of a learning experience. Simulation represents in the educational sense a new and different experience for the learner. As stated above, teaching for the most part involves the presenting of information either through lecture or text. Yet, students desire new experiences. William Thomas (1951) states that this desire, or wish, represents one of four types of forces that impel the human to action. The excitement generated by a seal hunting expedition (cf., Abt, 1966) or an encounter with a simulated class (cf., Twelker, 1967) brings the student new experience that ordinarily would not be possible except through real-life encounters. The role of the student in a simulation experience is more that of a participant in the excitement that is generated rather than an observer of the excitement.

The philosophy of simulation also implies a unique opportunity to integrate the cognitive, affective, and psychomotor aspects of learning. Eli Bower[1] has pointed out that if one were to emphasize just the cognitive objectives in education, the result might be "an intellectual giant with no emotions." On the other hand, if one was to emphasize the affective domain, the result might be an "emotional explosion with no rationality." Educators are often prone to separate instructional objectives into neat categories (cf., Bloom, 1953, Krathwohl, et al., 1964), and often neglect to integrate what has been thought of as separate. Further, the emphasis on passive reception through lectures, textbooks, and the like, often leave little room for the activities that integrate the various types of objectives in a way that is meaningful. Simulation offers teachers, for example, an opportunity to deal with their emotions in handling the problems that demand the application of previously learned principles in classroom management and instruction. Valid educational principles might prove of little value if the teacher reacted in a negative emotional manner during a demanding occasion of decision-making.

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[1] Personal communication.

It is interesting to note that browsing through a "pre-simulation" text on teaching (e.g., Mursell, 1954) brings to light some pedagogical "insights" that are as relevant today as they were 15 years ago. For example, "learning is well organized when it is richly meaningful to the learner" and "learning is meaningful in the proportion to which the situation or problem seems real or worthwhile to the learner, and in the proportion to which its essential interrelatedness is 'emphasized'." (Mursell, 1964, p. 39, 41-42). The problem with these principles, if indeed they be principles, is in the translation from theory to practice. How is learning made meaningful (relevant) to the student? How is the situation made real? Perhaps the philosophy of simulation can fulfill in part the requirements of Schwab and Fitzgerald, and bring the oft-quoted pedagogical principles that border on triteness into focus and utility. Perhaps the only price to pay is an open mind as the idea of simulation is pondered and practiced.

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II. The Design of Instructional Simulation Systems

Jack Crawford
Paul A. Twelker

This chapter explores how several major simulation centers look upon simulation design, and then outlines the approach developed at Teaching Research. Detailed step-by-step explanations are given for thirteen phases of simulation design. An effort is made to expose vital decision points that confront the designer as he develops simulation experiences.

Approaches to Designing Simulations and Games

Diverse approaches have been followed in designing simulation games. Below we have summarized our interpretations of those approaches used by three of the major producers of simulation games. Such summaries derive from the author's publications and our interviews with their staff. Responsibility for discrepancies between the summary description and the actual behavior of the designer is ours.

The Johns Hopkins Group

Fathered by James Coleman, this group of sociologists have created the leading social simulation games. Their games derive from areas of sociology in which they as professional investigators are most familiar: social interactions, institutions, and organizations. Two major goals appear to guide their efforts:

1) To bring into the classroom the high investment of energy and value that the student often gives to other activities

2) To reduce the discrepancy between school behavior and non-school behavior.

A strong emphasis upon research into the underlying social problems and interactions precedes the game. In general the development follows three steps:

a. research into the content,

b. development of a model based on the research,

c. development of the game based upon the model.

The game itself follows a four-step evolution:

1) its establishment and continuous tie-in with the research findings,

2) the development of the prototype model,

3) a continuous testing effort, and

4) revision of the game as a result of the testing.

Sarane Boocock, in an interview, suggested that she would have difficulty reducing to a manual, their approach to the development of a learning game. She suggests that research activity itself is a good model of their development of a simulation game. It is difficult to reduce the strategy and tactics of research to any simple manual guidelines. Her approach indicates a primary emphasis on the background content knowledge of the designer and secondary emphasis upon the logical steps to be followed in translating this content.

Games developed at John Hopkins tend to follow the purposive theory used by most sociologists. Players and groups in the game have certain goals to which they strive, they have various means of working toward these goals and certain constraints are put upon their efforts. Representation of the social environment, including people in it, is achieved through roles of the players and various kinds of rules.

Key dimensions to be considered in constructing the game include: 1) the polar dimensions of intellectual strategy versus role playing, 2) length of the game, 3) complexity of the game, 4) competitive aspects of the game. These include whether the competition is between teams or individuals, or whether the individuals are competing against some model of the world.

Our impressions were that the games designed by the John Hopkins group tend to be well based on the empirical data of sociology and have evolved through a long period of prototype development field trial and revision.

The Nova Group

The Nova Group located at the Nova Schools in Ft. Lauderdale, Florida, received its initial impetus and guidance from Layman Allen; Professor of Law, who developed the original Wff'n'Proof Game. The source for our comments below came from an interview with Lawrence Liss, of the Academic Games Project Staff.

Nova games tend to be non-simulation games. They are academic in the sense that they are often tied into the goals of typical classroom instruction. Two guiding considerations are: 1) Is the activity of the game itself enjoyable to players? and 2) Are specified learning outcomes being achieved? Attempt to simulate real world environments or interactions is not a primary consideration.

In initial phases of game development, two approaches can be used:

1) the search for an outside expert or office who has contributed in a given academic discipline some form of instruction which appears to be gameable.

2) A search throughout the school system itself for various aspects of instructions which could be converted into a game primarily to make it more enjoyable.

Steps then followed are similar in either case:

a) A rough game format is built. Guidelines here appear to be objective in terms of learning outcome. These usually are the kind of cognitive acquisitions typically stressed by classroom instruction. The game format itself, e.g., the chance, the player interactions, etc. is relied upon to put the motivation into the resulting game.

   Freed from the necessity to simulate any event or process and with an emphasis almost exclusively on cognitive concept of principal outcomes, the Nova group appears to have a clearer and more delimited task than other simulation designers.

b) The rough prototype is tried on local Nova students.

c) The revision follows based on the learning outcomes and observations and interviews of students' enjoyment while playing the game.

d) The revision is then tried with other local students and extended to different populations.

e) Further revisions if necessary, and then the game is considered ready for dissemination.

Games so designed tend to be more congruent with present classroom activities than most simulation games. Initiation and termination of the games is flexible and easily carried out. Nova games require only very small groups of players, often just two. Space and support requirements are minimal. And outcomes, as mentioned above, are compatible with those of the curriculum.

The Abt Associates Group

Probably the most prolific designers of simulation games in the country is the Abt Group, located in Cambridge and directed by Clark Abt. Dr. Abt has published several versions of his logic in game development. A summary of these is given in Table 1.

Table 1. Summary of Game Development System Used at Abt Associates

I. The Design of an Educational Game

1. A System Analysis of the Substantive Problem, Process or Situation to be Taught

   a. The educational objectives of the game are specified in terms of substantive scope, structural comprehension, factual detail, and relationship to other educational material.

   b. The resulting "problem space" is then subjected to a system analysis. The system analysis generally consists of identifying all the major decision-making entities, their material and informational inputs and outputs, and the resources and information exchanged by these decision-making elements.

   c. A sequential analysis is then made to determine the sequence and rate of flow of information and resources among the decision-making entities that have been identified.

   d. A decision analysis is then made of the decision-making entities, to determine what operations they perform on their information and resource inputs to produce their respective outputs. The decision analysis determines which "problems" are perceived in which way by the decision-making entities. Problem recognition is followed by a problem-solving response.

In sum, the system analysis identifies the major actors in a process, their interactions, and their decision rules in responding to each other's actions.

2. Simulation Design

Given the model of decision-making entities, their interrelations, and their individual decision rules developed by the system analysis, it remains to translate this analytical model into a human-player simulation, or game.

   a. The model must be translated into a social drama that involves the student's interest, and enables him to experiment actively with different roles and consequences of various "moves."

b. To achieve an effective balance between analytical "truth" and dramatic communication, some degree of simplification is needed to form the basic "plot" of this sociodrama or game.

c. The game teams, player objectives, allowable activities, win-lose criteria, and rules are then developed to achieve a maximum of learning in the participating student-player.

3. Refinement

Once designed, educational games are refined by a series of test plays, in which various awkwardnesses and distortions are identified and corrected. It is a form of iterative "tuning."

a. In tuning the game parameters, various design-tradeoff decisions must be made.

    (1) Realism (at the cost of ease of playing) versus simplifcation (at the cost of intellectual validity).

    (2) Concentration (at the cost of topical coverage) versus comprehensiveness (at the cost of detail and realism).

    (3) Melodramatic motivation (at the cost of calm analysis) versus analytical calm (at the cost of reduced emotional involvement and reduced motivation).

b. It is necessary to remember that educational games must operate within fairly rigid temporal, spatial, and behavioral constraints.

    (1) Game must be played by 20-30 students in one large room for a maximum of 50 minutes at a time.

    (2) Physical violence or loud outburst must be avoided.

The following points are meant to supplement Abt's formal description of the processes involved in designing a game. Such points stem from an interview with two game developers at the Abt group, Alice Gordon and David Sakawinski. These people were working on a series of economic history games. Steps they appear to follow include:

1) defining the area to be simulated,

2) identifying those critical processes to be developed into the game,

3) simplifying those processes so that they are gameable. For example, they felt that competitive processes were rather easy to transpose into a game while actions based on representation of affect were more difficult (and thus often de-emphasized).

4) identifying roles for players--the goals of each player and group of players appeared to be the first role consideration; then the processes, activities and decisions of players required for them to progress toward those goals must be identified.

5) bringing the above elements into congruence so that essential relationships will be perceived by the learners--a final and major game design objective.

Certain characteristics appear to typify the sort of game so developed: There was a minimization of role-playing and an emphasis upon decision-making. Routines were developed including graphic and concrete symbolic material so that most of the game activities could be played by slower students. The designers felt that there was a continual compromise imposed upon them between adequate representation of reality and the simplification required for a playable game.

In an attempt to describe their own work, these representatives from the Abt group felt that itemized description made the process appear too cut and dried. There was more inspiration and intuitive creation than any outline conveys.

The prototype was essentially a paper model developed in approximately two weeks. As soon as possible this paper model was tried with a group of students. The playability and impressions of the designer based upon watching the students and talking with them were the two main criteria used in revising the game. Three such prototype trials and revisions appeared to be typical. Designers wished they could extend this to further cycles but had found that time and money constraints usually prevented much more developmental work. In the final stages of development, increasing emphasis is given to the incorporation of graphic material into the game.

A Rationale for the Design of Instructional Simulation Systems

With the above brief review of the manner in which some of the major simulation centers in the country view the business of simulation design, the approach developed at Teaching Research will be outlined. In designing an instructional simulation system, or any instructional system for that matter, it is useful to think of a gap -- a difference between the learner where he is before instruction, and where he is after instruction. Before instruction, we assume that he lacks some knowledges or skills necessary to perform satisfactorily in an operational situation. After instruction, we assume that he possesses these skills. Our problem is to specify the learning conditions necessary to bridge this gap between the learner's initial repertoire and final criterion repertoire.

How best are these instructional conditions specified? Are there instructional methods effective in all kinds of learning activities? To be certain, there are some general rules-of-thumb that seem to hold in a variety of conditions, such as the provision for proper feedback, active participation, spaced practice, and so forth. Yet, it is clear that these guides do not lead us far enough down the road of instructional specification to be of much help at this stage in our technology. Too many decisions must be made in the course of specifying instructional conditions that cannot be answered by examining past research, theory, or intuition. Decisions must be made in the best manner possible, and this requirement has in large part prompted the approach to be discussed in detail below. This approach may be summarized as:

(1) Determining what shall be taught

(2) Determining how best it might be taught

(3) Validating the system.

In a systems approach to instruction, the systems designer (or "instructional engineer") has the task of creating and sequencing a series of learning experiences which will produce a previously stated behavior(s) on the part of the learner. To achieve this, one of the primary things the systems designer does is to define the instructional objectives or desired terminal performance outcomes. When a designer states what he wishes the student to learn in behavioral terms, he provides a means for looking at the instructional content in a facilitative manner, as well as the criterion measures required to test whether or not the students have learned. By examining the instructional content in light of terminal behaviors, the designer in effect facilitates the specification of information that pertains to the design of instructional methods. The instructional methods and materials, when implemented according to some administrative instructional plan, become the instructional program -- after exhaustive tryout and revision. At the completion of instruction, criterion measures are applied to obtain an indication of the adequacy of the program. An integral step in the development of the new system is the provision of self-corrective feedback all along the way that is used to modify the system if the desired effects have not been achieved. The learning experience is continually monitored and empirically tested until effective.

The rationale above has been stated in general terms to point up the fact that a simulation experience should not be conceived of as an isolated experience taken out of the context of the overall instruction. The term, "simulation system" infers that the simulation component of the system is accompanied by other (non-simulation) components. The components describe what curricular units precede, accompany, and follow the actual simulation exercise. Also, the word "system" connotes an interrelated set of components ranging from media and manuals to student learning materials.

The guidelines are most appropriately used for curriculum development projects where the designer is interested in, but not committed to simulation. The guidelines assume that the designer is openminded with respect to the "hows" of instruction. For those who would not be so openminded, such as a researcher who wants to evaluate simulation as an effective training medium in a particular field, the guidelines need some modification. In such cases, the researcher cannot check the appropriateness of simulation against other alternatives since he has previously "locked" himself into simulation. Also, he cannot specify the type of simulation since this too is predetermined. Incidentally, it is hoped that the researcher has determined some "fit" between the use of simulation and the instructional requirements prior to the decision to use simulation as the vehicle for instruction.

One final word. The guidelines that are presented may be used with instructional problems involving whole curriculums, or involving small units. However, it should be recognized that the specific procedures and outlines may be vastly different. When working in the context of a curriculum, many simulation systems may be designed. When working with a specific problem only one system may be designed.

Specific Steps in Designing Instructional Simulation Systems[1]

Step 1. Define instructional problem

In defining the instructional problem, the designer answers questions such as:

> What is the problem? What are the proposed solutions
> to the problem? What information led to the definition
> of this problem? Is this information enought to act
> upon, or is more required? What is the source of
> further information?

Before one can improve instruction, he must step back and examine in broad terms what preceded his decision to develop a new instructional system, and what might follow if his intentions were realized. What condition has motivated his tampering with the status quo, and why does he believe that intervention can improve the conditions? In addition to defining the problem, the designer should make a thorough analysis of the context in which the system is to operate. This step probably occurs simultaneously with Step 2.

Step 2. Describe the operational educational system

Why analyze the operational system? Hamreus (1968) states that "we can no longer afford to engage in the process of modifying components of the educational system as if they were interchangeable; in changing any of the entities of the system we change the system-structure." What is suitable for one set of objectives taught in a given environment may not be effective for the same objectives taught in a different environment that has different constraints placed on it. For example, an excellent instructional system that is designed for teaching one child at a time may not be appropriate for teaching two or more simultaneously. The constraints of the system in which the designer expects to operate must be described.

One more point. What is thought to be a problem may not be the actual or total problem when the system is examined. Most likely, the analysis will uncover other conditions which must be related to the problem.

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[1] The thirteen steps are summarized in Figure 1.

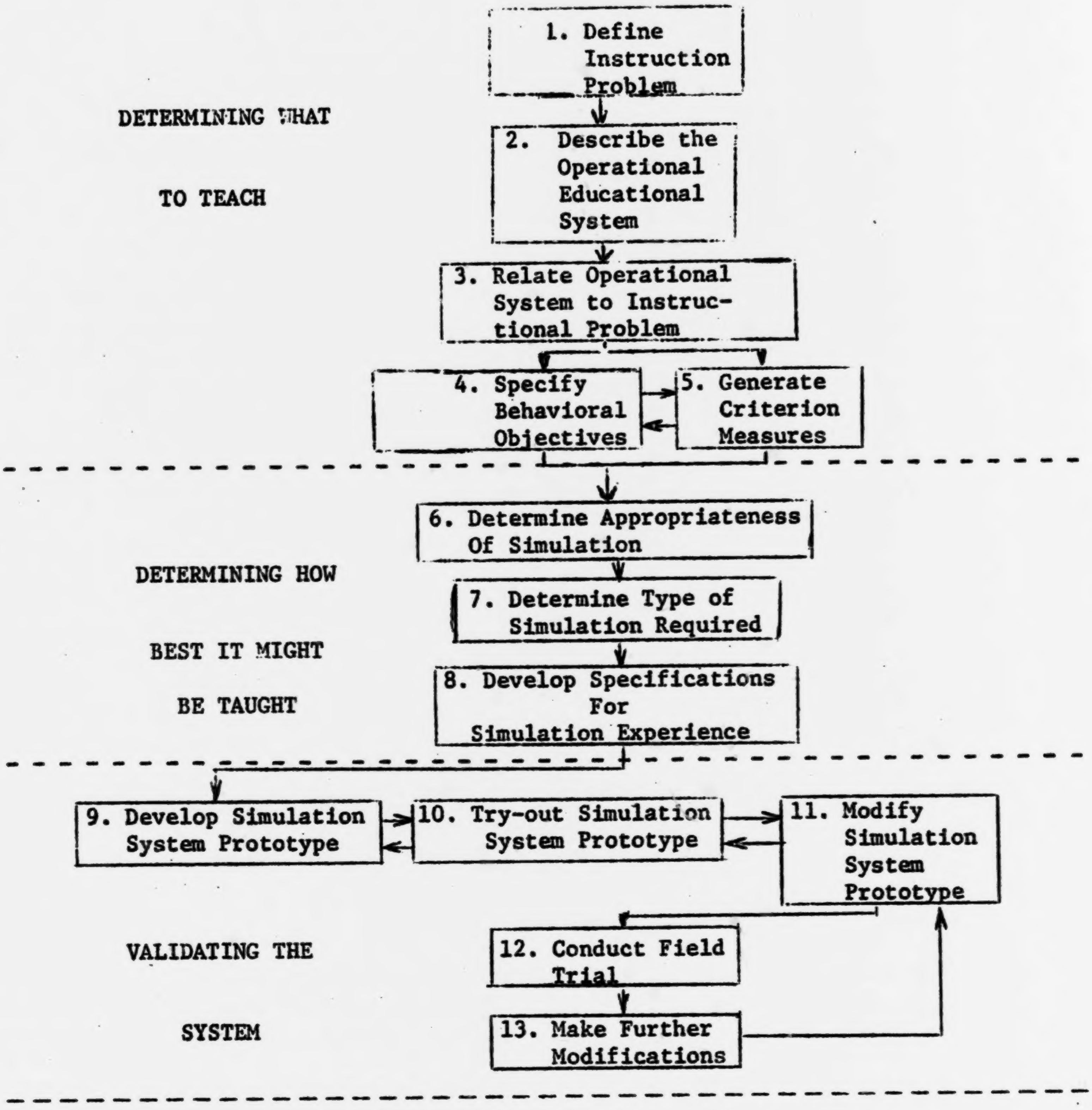
DETERMINING WHAT TO TEACH
1. Define Instruction Problem
2. Describe the Operational Educational System
3. Relate Operational System to Instructional Problem
4. Specify Behavioral Objectives
5. Generate Criterion Measures
DETERMINING HOW BEST IT MIGHT BE TAUGHT
6. Determine Appropriateness Of Simulation
7. Determine Type of Simulation Required
8. Develop Specifications For Simulation Experience
9. Develop Simulation System Prototype
10. Try-out Simulation System Prototype
11. Modify Simulation System Prototype
VALIDATING THE SYSTEM
12. Conduct Field Trial
13. Make Further Modifications

Figure 1.
Steps in the Design of an Instructional Simulation System

In analyzing the operational system, the designer must define:

Target Group -- the learners for whom the system is being designed.

- Age
- Previous educational level
- Special characteristics
- Sex
- Number
- Entry skills

Other constraints must be considered

- Number of personnel available to work on the project (manpower)

- Support equipment (machines)

- Personnel scheduling, available curriculum materials, description of course limits and developmental time (procedure and materials)

- Administrative limits (management)

- Facilities (setting)

- Money available for the ongoing system, and money available for developing the new system (funds)

- The instructional philosophy or orientation that guides the system as well as the designer (educational orientation)

Finally, the designer must consider the contextual environment of the learner.

- Living or dormitory arrangements

- Study time

- Free time

- Social peer pressures

In summary, the designer should examine any element that he feels helps him to define the problem more clearly, and to propose appropriate solutions. In many cases, the analysis of the system may require help from subject matter specialists, and "natives" who have a thorough grasp of the educational system, and its merits and deficiencies.

Step 3. Relate the operational system to the problem

Now that the problem has been (tentatively) identified, and the system in which the problem exists has been analyzed and described, these inputs must be related to each other. It makes little sense to think of an educational problem in isolation to the context in which it is found. For example, it might be difficult for a designer to incorporate Skinnerian principles of learning in an operational system that is based on Guthrian principles. The relating of the initially identified problem with the system may cause the designer to re-define or re-structure the problem. In some cases, the designer will face the choice of delimiting his interests and choosing certain aspects of the problem(s) he has identified. This is based on the assumption that the more one knows about the system, the more problems will be perceived.

Step 4. Specify objectives in behavioral terms

The discussion below will center largely on four concepts: "terminal objectives," "enabling objectives," and their counterparts, "terminal performance measures" and "enabling performance measures." A clear understanding of these concepts and how they are related to each other is mandatory if the designer is to achieve any degree of success in Step 4. Consider the following points.

> All objectives that are stated behaviorally must include four components: the target audience, the behavior desired, the conditions of performance, and the degree of attainment (cf., Paulson, 1967). Objectives may involve one or more of these realms: cognitive, affective, psychomotor.
>
> Terminal objectives state in precise terms the behavior the learner is expected to exhibit after instruction, e.g., "Trouble shoot five classes of problems on a six-cylinder motor...."
>
> Enabling objectives state in precise terms the specific knowledges/skills the student must learn in order to arrive at the terminal performance, e.g., "Identify the parts of the six-cylinder motor," "List the steps in trouble shooting the five classes of problems;" and so forth. Enabling objectives state prerequisite behaviors to the terminal behavior.

> Terminal performance measures assess directly the desired outcome behavior.
>
> Enabling performance measures assess the prerequisite knowledges/skills that must be learned before the student can exhibit the terminal behavior.
>
> Any objective may be considered a "terminal" objective, even though it was previously labeled an enabling objective. It depends on the outcome behavior desired by the instructor, and not on some inherent quality or make-up of an objective. Likewise, what are called "enabling performance measures" on one occasion may be termed "terminal performance measures" on another occasion, if they measure the desired outcome after instruction rather than the requisites to that behavior.

There has been confusion in some minds regarding the "hows" of specifying behavioral objectives, whether they be enabling or terminal. This discussion is not meant to be an exhaustive "cookbook" on the subject.[2] Rather, it is meant to clarify the relationships between the initial steps of simulation design discussed above, and some general considerations about objectives that seem important.

Where do objectives come from? It is easy to assert where they do not come from. They don't simply materialize out of some ethereal, intuitive feeling about a subject. Rather, the designer relies on inputs from the previous steps to construct the objectives. Typically, the designer might begin by examining the unique key words, phrases, concepts, definitions, and rules that he frequently uses in the instructional unit. He looks at their natural sequence. That is, he analyzes a set of key concepts or definitions to see which are requisite for learning other key ideas. He constructs a hierarchy of principles that tell him in what order these principles should be taught. This technique of looking at his course content is a constructive way to identify those objectives that are "terminal," and those that are "enabling." The formal analysis of objectives is based on procedures used by Gagne (1962; 1965) and has often been referred to as hierarchical analysis or learning set analysis. Basically, the analysis as used in the context of specifying what to teach requires the designer to choose some performance (that may or may not end up to be a terminal performance), and successively asking the following question: "What kind of capability would an individual have to possess if he were able to perform this objective successfully, were we to give him only instructions to do so?" In some cases, the designer may find it easier to work with principles or concepts rather than the behaviors that reflect the knowledge.

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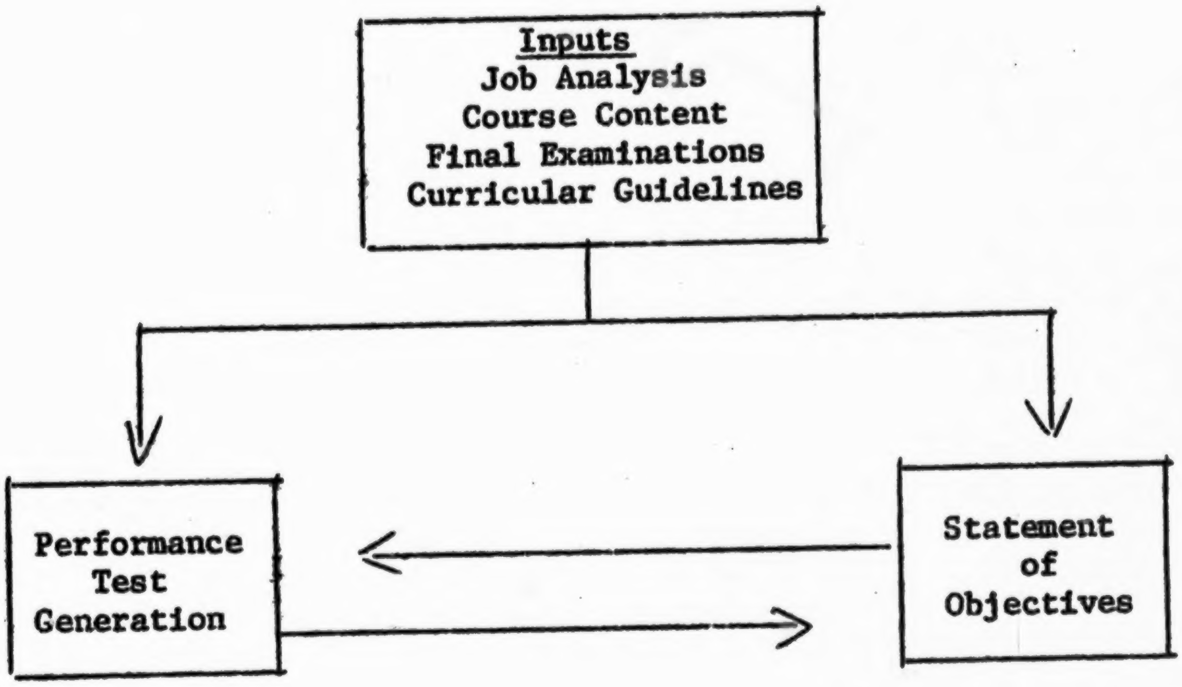
[2] The construction of objectives is discussed in detail by Walbesser (1968), Paulson (1967), and Mager (1962).



Constructing Behavioral Objectives

Where else does the designer look for objectives? In addition, he may check the final examinations he has been giving, and attempt to assess the degree to which they really tap the skills desired on the part of the student. He sees if there are more life-like settings that could be developed that might more closely approximate the real-life skill that is being taught and tested. Perhaps a case-study, filmed situation, or taped dialogue would be a better assessment tool. The designer actually generates specifications for some of these tests. Then he asks the question, "Does that behavior satisfy me that the knowledge/skills have been taught?" The designer infers knowledge from performance. During this process, he has written the specifications for the behavioral objectives largely through an examination of the tests and content he gives. In most cases, the designer will not initially state clear behavioral objectives, including the target audience, the behavior, the conditions of performance, and the degree of attainment before he begins the generation of test item specification. Hamreus (1968) states that "by developing measures for assessing criterion performance at the same time as objectives are determined it eliminates the pitfall of assessing that which has been taught. It also requires that close scrutiny be made of the behavioral objectives which has the advantage of uncovering ambiguities or gaps in the objectives."

Summarizing, objectives are not constructed in a vacuum. Their successful construction depends on many varieties of input. Neither are objectives usually constructed prior to performance tests. It is more accurate to say that they might be constructed simultaneously with test generation. It should be mentioned that to this point, the designer probably will not have to secure the services of a measurement expert, as his test generation has not gone beyond the stage of gross specification.

One other point should be emphasized. Educational objectives may be thought of as either stated (intentional), or unstated (unintentional). Stated objectives are those determined by the designer to be important and relevant to his problem. Unstated objectives are those which are not verbalized by the designer, but which may be just as appropriate as those stated. In designing instructional simulation experiences, where vivid experience is the keynote rather than reported experience, it is especially important that unstated objectives are considered. For example, extreme competition in a simulation game may produce the desired stated objectives, but at a risk of promoting dishonesty, thus not fulfilling an unstated objective regarding propr interpersonal behavior. This same simulation game may also act against building healthy personal respect, and in effect, violating another unstated objective. The designer must be on guard to consider these unstated objective throughout the design and building of the system.

Step 5. Generate criterion measures

Simultaneous with determining behavioral objectives is the development of criterion measures. These take two forms:

(1) terminal performance measures, and

(2) enabling performance measures.

The measures for assessing terminal performance determine whether or not the stated outcome behaviors were acquired by the learners as a result of the instructional experience. The measures for assessing enabling performance determine whether or not prerequisite behavior necessary for adequate performance on the terminal objectives have been acquired during instruction. A terminal performance measure may be assessed by paper-and-pencil tests, situational response tests including in-basket techniques and motion-picture tests, or in the operational situation (see Chapter V). On the other hand, enabling performance tests are usually of the paper-and-pencil variety, although they certainly are not limited to this mode. Again, the designer should pay some attention to generating measurement instruments for unstated objectives.

Step 6. Determine appropriateness of simulation

Simulations are often more costly in both preparation and performance than more conventional forms of instruction. To justify this additional cost, simulation must offer marked advantages. We have listed below seven possibilities in which simulation may offer a useful and cost-justifying alternative:

1. An emphasis upon affective behavior.

If the objectives emphasize an emotional or attitudinal outcome, simulations may be appropriate. The kindling of affect has struck all observers as an obvious hallmark of most simulations.

2. Combining affective and cognitive behavior.

Simulations probably stand pre-eminent among all instructional techniques in this respect. Planned integration of feeling and thought can be effected by simulations, particularly learning games, over a range limited only by concerns of practicability. The Parent-Child Game and the Carnegie Tech Game provide examples of the possibilities.

3. Motivation to initiate a sustained learner activity.

Again, a universal observation of simulations is the high interest and involvement engendered. This consideration alone may justify the development of an initial or periodic simulation within a training program.

4. Emphasis upon the learner interacting with a complex and reactive environment.

The case referred to is one in which the objective is to represent a social or man-machine system in such a way that:

(a) the learner can interact with it,

(b) the system will react to the learner's moves,

(c) the learner can discover the effects of alternative decisions.

Computer-based simulations have frequently been used for such objectives. Political and economic games are often so employed. In fact, simulation of one kind or another may be the only route if the objectives involve more than a detached cognitive appreciation of the possible moves and consequences.

5. Emphasis upon incorporation of the behavior within the personal domain of the learner.

This objective refers to the learner making the concept, principle or value learned part of himself. Learners often pass tests without developing any personal meaning or applications for the objectives. Simulations, in which a high degree of commitment can be introduced, offer this possibility.

6. The application of behavior, particularly under a variety of contexts.

For many objectives, such as learning a language, intensive practice or drill is required. Usually, this becomes boring for the learner and he fails to respond appropriately. Simulations provide an interest-sustaining mode that may carry him through the requisite exercise. Furthermore, additional variables can be carefully introduced into the exercise, so that the learner can continue to function appropriately in a more and more complex environment.

7. Emphasis upon a "perceptual frame" to sensitize and direct the learner.

Putting the learner into a desired "set" to shape the pattern of his selections of input and output is handily accomplished with simulations. As an example, Teaching Research staff recently designed a game based on the slave trade. Participants placed in the role of Yankee rum-molasses-slave traders become quickly enveloped in the values and attitudes of the slave trader. While the game was played, present-day humanitarian arguments fell on deaf ears -- the ears of some who were in other contexts, militant spokesmen for minority rights. The unique potential in this case is that the learner does not simply learn to talk about the frame of reference -- in this case, the slave trader and others supporting the economy. For a time, he possesses it, or it possesses him. The power to produce such frameworks opens new perspectives of instruction.

To balance the foregoing somewhat ebullient arguments, let us briefly describe the debit side of the ledger. For which objectives is simulation of questionable use?

The answer is straightforward: the acquisition of cognitive knowledge as measured by typical tests. Many of our customary instructional objectives relate to the acquisition of knowledge. Acquisition of verbal symbols so that the learner can recognize them, enumerate them, and regurgitate or recall them, all constitute a large share of present instructional intent. Generally, simulation offers no marked advantage here. Learning names, concepts, and principles so that they can be recalled verbally or recognized among alternatives usually is more efficiently accomplished with other kinds of instruction. Since this sort of acquisition represents a large share of present educational objectives, simulation is not the most appropriate technique for a great deal of our present educational effort.

Exceptions to this generality should be noted and stem from the simulation indicants enumerated above. Conditions that indicate the fruitful use of simulation for acquisition of symbolic knowledge include:

1. Learners who are not interested.

2. Learners who are not adept at typical skills required for acquisition, such as reading.

3. Objectives place emphasis upon contextual exercise, uses and applications of symbols.

Other considerations may mitigate against the choice of simulation. These include:

1. High costs

    a. The development of the instructional package employing simulation often requires prohibitive quantities of time and money. A straightforward information-presenting format, such as a text, a pamphlet or tape may be much less expensive. Designers for Abt Associates have estimated that two staff members working six months are required to create a simulation. Sarane Boocock estimates that two to three staff members working approximately 50% time for a year are required to develop one of the Johns Hopkins games. Complex military trainer simulators sometimes require several years.

    b. Conduct of the instruction.

        More information can be presented in less time by other means. If "covering the material" is important, simulations are a poor bet.

2. Problems of intrusion into current instruction.

    Learning games often introduce considerable changes in noise level, physical movement and teacher role that are objectionable or at least highly suspect to some instructors and administrators. Furthermore, additional training may be required for staff to implement the simulations.

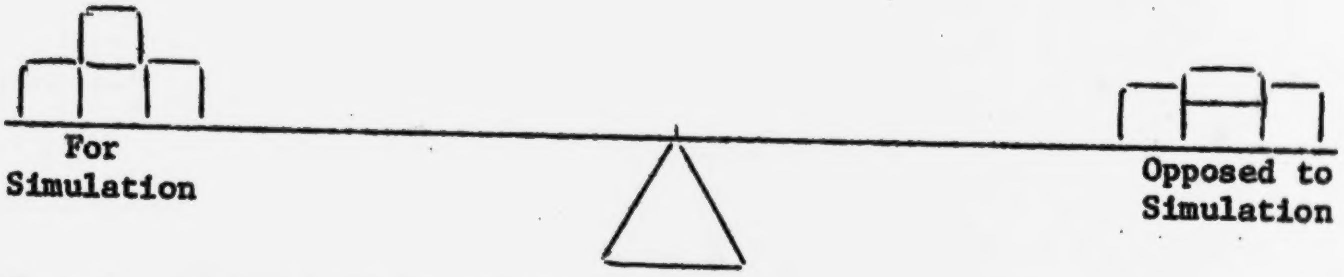
3. Difficulty in evaluating learning gains.

> In part, because the marked advantages of simulation lie in those human processes difficult to measure, demonstrable advantages (or losses) may not be reportable. On typical information recording tests, no advantages are revealed.

A decision maker's balance might represent the following considerations:

High motivation
Cognitive-affective integration
Personal involvment
Interaction with complex reactive environment
Prolonged exercise

Acquisition of information
Economy in development
Protect present system from disruption
Clear measures of learning required
Staff training required



Step 7. Determine type of simulation required

If a decision has been reached to consider the use of simulation, the next set of decisions relate to the kind, or the attributes, of the simulation to be designed. The three major possibilities are:

Interpersonal Ascendant Simulations

Machine/Media Ascendant Simulations

Non-simulation Games

I. Interpersonal Ascendant Simulations

> These refer to the role-playing and decision making, player-interacting simulations. Typically such games as Consumer, Crisis, and Manchester number among this type. The interaction between learners carries a large share of the instructional burden.

II. Machine or Media Ascendant Simulations

In these, the instructional burden is carried by media (e.g., slide-tapes, films, programmed instruction, computer output, and so forth). Examples include flight trainers; systems trainers such as the weapons systems simulators used by the military for submarine crew training; computer-based business games; the classroom simulations as developed by Teaching Research. Mixtures of the two categories are frequent in many of the business games such as Intop and the Stanford Business Management Game, where emphasis alternates between interaction with the machine and with the human players.

III. The third category Non-Simulation Games - is included, despite its non-sequiter label, because of the large number of learning games which are not designed to simulate a model of reality. The Nova games, including Wff 'n' Proof, On Sets, and Equations, are of this sort. They are designed to bring the advantages of game activities to instruction, but are not simulating any social or physical system. They provide exciting and competitive applications of concepts and principles drawn from formal disciplines.

We are unable to offer precise rules for deciding among these alternatives. However, a few overall guides can be stated.

A. Advantages of the Media/Machine Simulation

1. Control. Input can be constructed to specification. Films, slides, and other media can be made as the designer intends. Human players, however carefully instructed, tend to contribute variance to the system. Furthermore, the media presentation, once made is reproducible.

2. If variation is desired, planned variation over selected instances throughout a wide range of problems can be built. For example, in classroom simulation materials developed at Teaching Research, the classroom management problems simulated extend across an empirically derived range of situations. Such controlled variance can be used to enhance transfer of learning. With human players, planned variation is more difficult.

3. Often the input needed cannot be conveyed other than by a machine component. Complex visual stimuli such as those presented to a carrier

pilot attempting to land cannot be transmitted by word or by action of fellow players.[3] In this case, "one picture is worth a thousand words." It has been suggested that about 85 per cent of learning is through the visual sense. Generally, psychomotor and perceptual learning require a media/machine emphasis.

4. Low entry skills and limited response repertories of the participants can prevent an interpersonal-ascendant system for functioning. Machine systems can be designed to provide components and processes the participant players cannot perform.

5. Traditional teacher control is not usually threatened by machine systems. Although the foci of control may be located at the machine, this seems an acceptable temporary substitute. Interpersonal-ascendant systems shift control to the learner participants.

B. The interpersonal ascendant simulations offer the following advantages:

1. Usually, simpler and less expensive materials are required. Simulation games may require no more support than a pamphlet rule-book.

2. Some processes are difficult to build into machine components. Interaction, appropriate to the context, between a player and other people may be difficult to represent on a machine. Decision-making, particularly when based upon qualitative data problems to software builders.

3. By placing the burden of simulation upon the participants more can be learned. The players learn processes by enacting them.

4. Models which emphasize human interaction are most readily transposed into interpersonal-ascendant simulations. Thus, areas within the social and behavioral sciences are most adaptable to interpersonal ascendant systems.

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[3] Such a simulation has been developed by the Naval Training Device Center, Orlando, Florida.

5. Provisions for individual differences are often costly or difficult to provide in machine systems. But with interpersonal ascendant systems slow learners can play a slow game. Or, a simplified version and a more advanced version of a learning game can be designed. Such versions, for example, are provided in the Economic Systems Game.

6. A continuous, and appropriately timed, feedback is easily designed into interpersonal simulations. Furthermore, the source of the feedback stemming from peer learners is itself a possible advantage.

C. Non-simulation games, derived from wholly formal, reality detached, systems offer certain advantages:

1. Their development is somewhat easier. Such use stems from the clarity and coherence of the formal system on which they are based.

2. The completed instructional package is relatively inexpensive. Formal aspects are readily represented by dots, lines, letters, numbers, etc.

3. They are easily both inserted and terminated within a curriculum.

4. They are generally acceptable, having a supporting tradition of respectability, e.g., the spelling bee.

5. Few participants, often two or even one are needed. Others are easily accommodated.

6. Learning objectives, which are usually the acquisition and exercise of concepts and principles, are congruent or identical to standard course objectives. No change of teacher orientation, or new problems of measuring achievement are presented.

Step 8. Develop specifications for simulation experience

A common error that novice simulation designers make is to assume that the simulation exercise represents reality per se. They fail to realize that the simulation is not based on reality directly, but a model or theory of reality. In Abt's words, "a model is a simplified representation of objects, states of objects, and events" (Abt, 1966). Basically, a model is a theory about a reality representing selected phenomenon. In other words, the model is a representation, and is in some way removed from reality. It might be appropriate to say that a simulation will only be as good as the model on which it is based. The model is usually stated in general terms and includes many variables that may be deleted or altered in the simulation. Thus, the simulation is a representation of the model but not an exact image. Changes have occurred.

When one sets out to describe reality, several approahces may be used. He may take a picture or draw a schematic of some real-life situation, event, or object, or he may physically model a real-life system (concrete or physical models). If these pictorial (iconic) or concrete models are accurate, his simulation may be designed to be practically identical to the real-life counterpart. Or the designer may be faced with the problem of using a set of symbols such as words (semantic or symbolic models) to describe a complicated historical or eeconomic situation. In this case, the model may or may not represent closely the real-life counterpart. It behooves the simulation designer to construct and use the best fitting model he can, so that his simulation that he subsequently builds has a fair chance of representing the relevant aspects of reality adequately. If the model is not a good representation of reality, that is, it distorts reality or omits relevant aspects of reality, and the simulation designer does not recognize this, the simulation has little chance of instructing learners in appropriate behavior. Of course, under these conditions, no other instructional system would be able to communicate without error.

It should not be construed from the above remarks that the model must coincide in every detail with the real-life counterpart. Not at all. Models must, in necessity, simplify reality. Generally, the more abstract the model, the greater the simplification. In modeling a complex situation that involves interrelated decisions from many entities, it would be presumptious to presume that all relationships and components in the situation could be precisely specified in mathematical (or any other) terms so that the coincidence of model to real-life was 100 per cent; that is, the model would be capable of being used to predict correctly in every instance it was employed. The worth of a model should be measured, not so much by its complexity and coincidence with reality, as its ability to lend itself to simulation, and the relationship of the model to the learning objectives.

Model building is a complex task, and it is not assumed that all simulation designers are equipped to perform such a feat. In many cases, the designer will employ the services of a colleague to help him build the model, or perhaps, find a previously developed model that would be suitable for use.

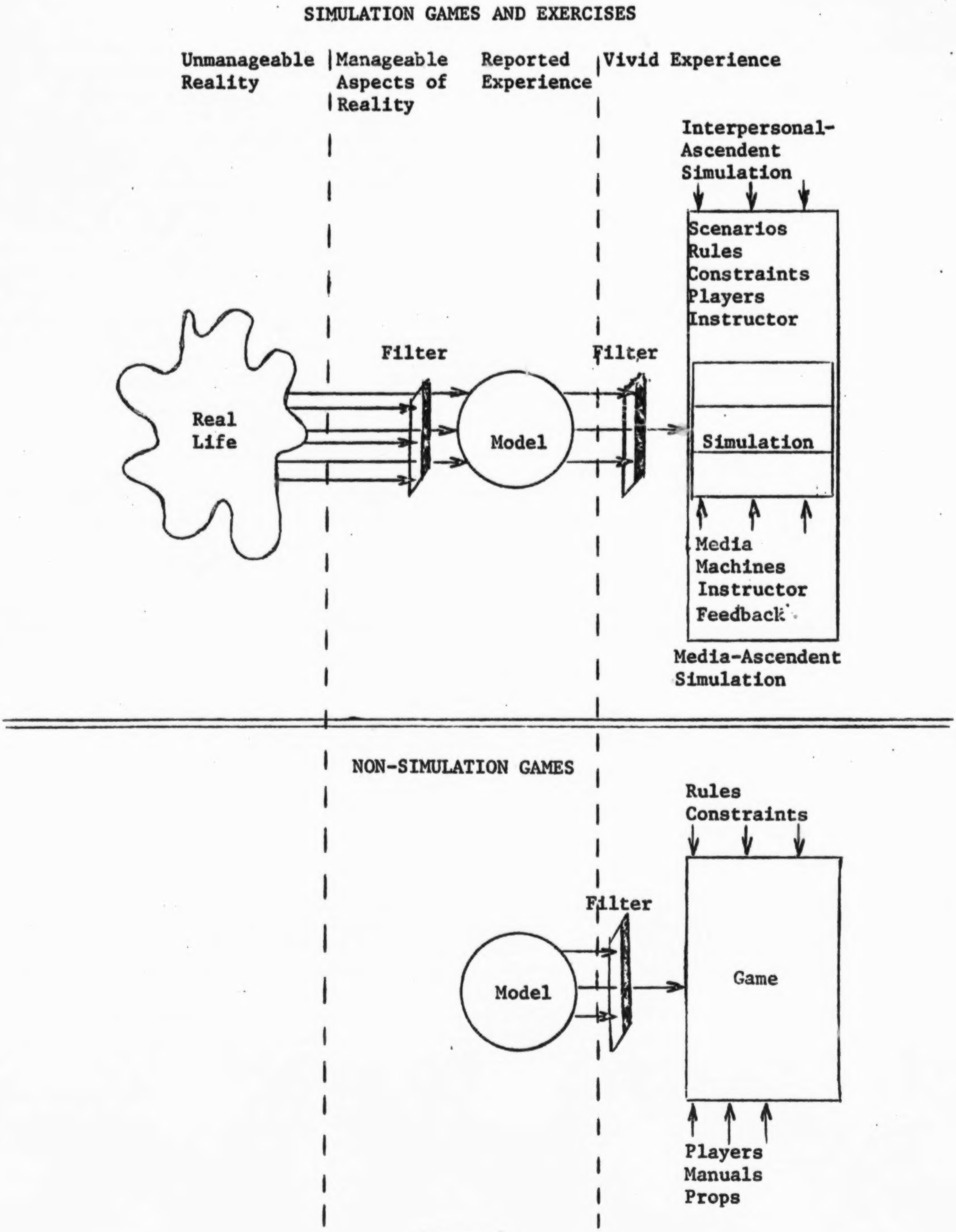

SIMULATION GAMES AND EXERCISES
Unmanageable Reality
Manageable Aspects of Reality
Reported Experience
Vivid Experience
Interpersonal-Ascendent Simulation
Scenarios
Rules
Constraints
Players
Instructor
Filter
Filter
Real Life
Model
Simulation
Media
Machines
Instructor
Feedback
Media-Ascendent Simulation
NON-SIMULATION GAMES
Rules
Constraints
Filter
Model
Game
Players
Manuals
Props

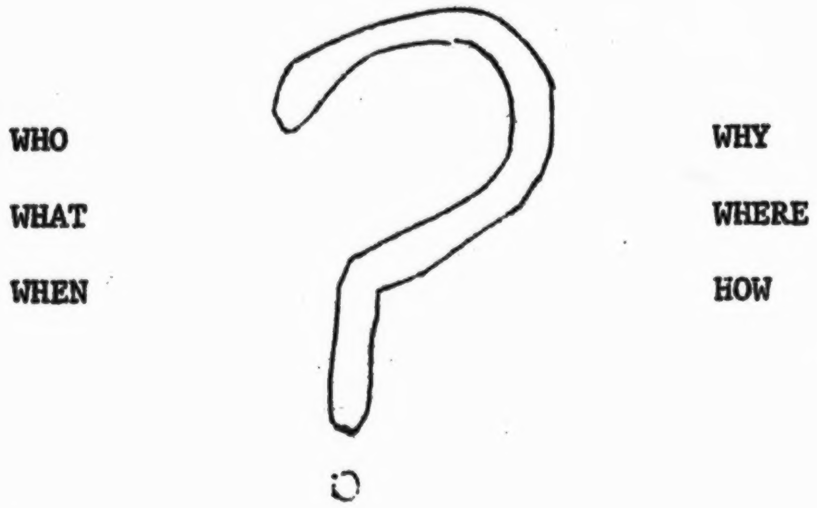
Figure 2.
Graphical relationship between
reality, models, and simulations

It should be recognized that when the designer chooses to build a non-simulation game, he still is dealing with a model (see diagram). Yet, there is no attempt to represent real life, except insofar as the logic, numbers, words, or symbols are meaningful.

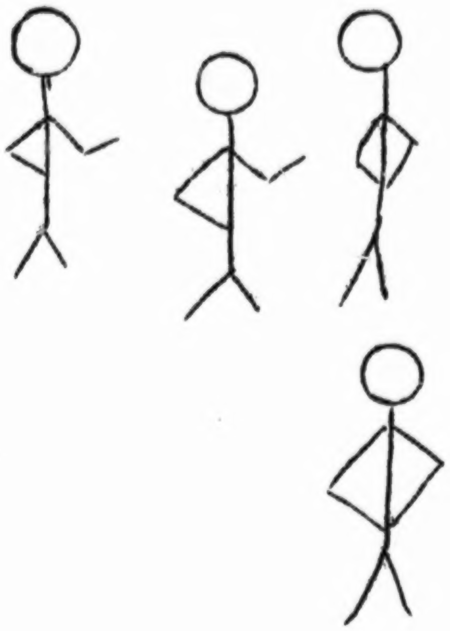
Now that the designer has at hand two crucial components, (1) the learning objectives, and (2) the model to be simulated, his first major task is to select, and transpose, those features of the model which will best contribute to the attainment of the objectives. This "remodeling" of the model includes the following operations, as exemplified in the design of a simulation game.

1. Identify scope of game. The designer should identify a situation or conflict that will be simulated. In addition, he should describe in some detail component stages or parts of the situation. Included should be:

Location
Specify activity
Setting
Cause
Time



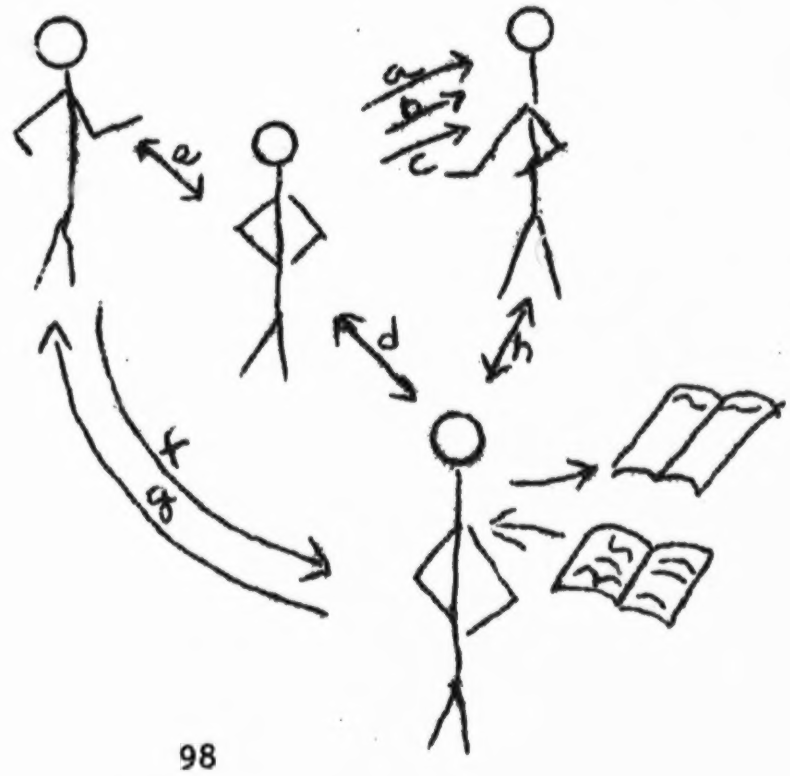
2. Identify the decision-making entities. All of the decision-makers who will (or might be) represented in the game, either by the players themselves, or the system, should be identified. If possible, they are identified as to their relevance and contribution to the stated objectives. Irrelevant decision-makers, or those that are tangential to the stated objectives, are listed for possible inclusion if they substantially: (1) make the game more playable; (2) heighten the realism; (3) enhance the motivational quality; or (4) enhance the objectives. Each decision-making entity should be identified in terms of the relevance or importance in each stage or part of the situation previously identified in the first step.



It might be helpful at this point to describe the motives or personal goals of each decision-making entity. A short paragraph describing the decision-making entity would be useful in later design work.

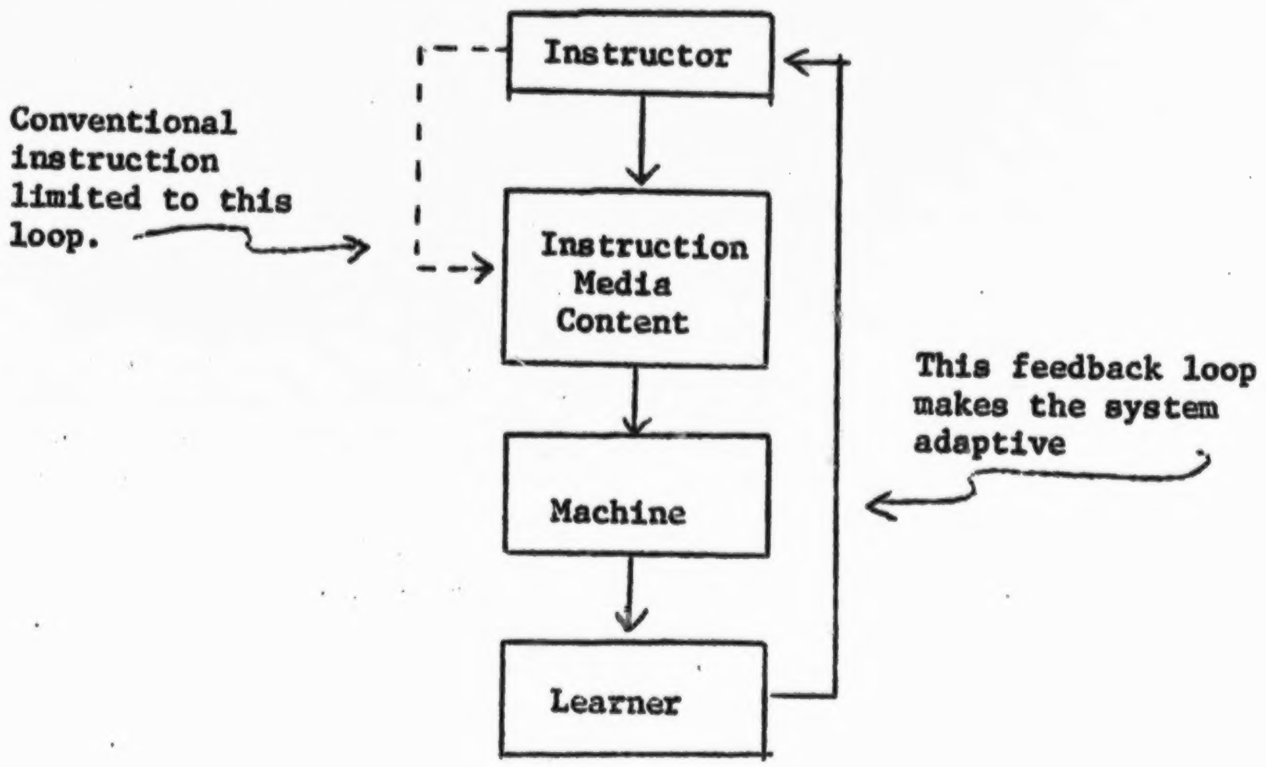
3. Identify the operations to be exercised. Next, the designer takes a close look at what happens between the decision-making entities. Typically, the interaction between each entity will be listed. The following points might be listed:

Direction of information flow
Type and quantity of information
Form of the information (i.e., discussion, command, message, etc.)
Material content
Information resources of decision-makers
Rate of flow of information
Frequency of information flow



Again, the designer should attempt to determine which interacts best exercise the behaviors called for in the objectives. It should be mentioned that less relevant interacts may be included in the simulation for the same reasons given above. Also, each interact should be identified as to its significance in each stage of the situation.

In designing simulation exercises that involve media, or machine-ascendant systems (e.g., classroom simulation, flight trainers, systems simulators(, it is valuable to consider the figure below.


Instructor
Conventional instruction limited to this loop.
Instruction Media Content
This feedback loop makes the system adaptive
Machine
Learner

An Adaptive Man-Machine Instructional System

The teacher outputs information to the learner through the machine. The learner reacts and the teacher changes the instruction accordingly. The teacher may be physically present, as in classroom simulation, or may be physically absent. In this case, a monitor senses student action and preprogramed instructional avenues are selected and presented to the learner. An alternate to this approach is when the learner acts as his own monitor.

An examination of the figure reveals that the feedback loop makes the difference between media such as instructional films where communication is one-way, and an instructional simulation system where communication is two-way, that is, between instructor and learner, and back again. This two-way communication link assures active participation on the part of the student.

Step 9. Develop simulation system prototype.

At this point, a good share of the work of simulation system design has been accomplished, and the "fun" part of building the system begins. If the designer has "done his homework," development should proceed at a fast rate. The main task is that of translating instructional "blueprints" into prototype. The more complete and thought-out the "blueprints," the faster and eaiser the development. Although the blueprint should be adhered to as closely as possible, the designer should feel free to vary certain specifications if the production effort clearly calls for this. It should be recognized that the designer will have a certain number of production decisions to make that are not specified in his specifications from Step 8. Yet, these should represent relatively minor decisions. By the time the designer arrives at Step 9, he should have a very clear idea of the nature of the system and possible problem areas where production techniques are certain.

Step 10. Tryout simulation system prototype

An empirical tryout of the system is mandatory. The tryout is limited in nature. If possible, small groups of learners, or even one learner at a time where appropriate, are taken through the system by the designer(s). Close monitoring of the learners is undertaken. Analysis of the system includes empirical data on whether the desired outcomes, both terminal and enabling, were observed, but not limited to this. Learners may be requested to verbalize problems with the materials, and suggest alternate strategies. It should be noted that the limited tryout of a system such as a simulation game may "look" quite different than a tryout of a media-ascendant simulation. A learning game that involves whole classes is quite difficult to monitor without constant "stopping down" of the game. The video-taping of such tryouts is an extremely effective way to capture activity for later analysis with a select group of learners sitting with the designers. Members of different teams could help identify where lags in timing occurred, vital relationships between players or teams did not properly develop, and so forth.

It should be emphasized that the tryout is limited in scope -- its objective is to gain valuable information for the revision of the system or system components. This is why enabling performance measures are analyzed, as they help the designer detect weak points in the system that result in less-than-adequate terminal performance. In some cases it may be conducted successively. Sometimes, the simulation may be tried out on colleagues before using learners that represent the target group so that responsible criterion may be obtained. In any case, tryout leads to the next step, modification of the system.

Step 11. Modify the simulation system prototype

Three major decisions are made during this step:

(1) If the system seems appropriate for obtaining the stated objectives, how can it be improved?

(2) If the system does not seem to be appropriate for obtaining the stated objectives, how can it be changed?

(3) If the system does not seem appropriate for obtaining the stated objectives, should it be discarded in favor of a non-simulation system?

These decisions may be made during the actual production and concurrent tryout of the prototype simulation or they may be made after a consecutive production and tryout sequence. In any event, the designer must ascertain if the type of simulation system chosen is appropriate, and if so, what can be done to improve it. In some cases, the designer may even decide to discard simulation as an inappropriate technique, either due to cost, faulty design work in steps 7 and 8, or other factors. Needless to say, the designer may recycle through the steps of production, tryout, and modification until he has achieved satisfactory results with the system, or has determined its inappropriateness as discussed above. When the system is developed to a point that all components are in a form suitable for use by others independently, then the system is ready for a field-trial by selected target-instructors.

Step 12. Conduct field trial

The field trial serves to aid the designer in determining if his newly developed system is capable of "standing by itself," that is, being used in the field under operational conditions by members of the target population. Designers often neglect this crucial step, reasoning that "since I was successful in using the system, everyone else can use it now." Unfortunately, it is the rare system that is capable of being used in such a manner. The safest thing a designer could do is to subject his system to a trial under field conditions. When this is done, the designer may wish to collect data concerning:

(1) Stated outcomes - effectiveness of the system in achieving the stated objectives;

(2) Stated outcomes, such as, attitudes of learners and instructors toward the system; retention or transfer measures; other measures of motivation; and

(3) The manner in which the system was implemented -- conditions, accurate descriptions of learners, setting, etc.

In some cases, the designer might consider securing the services of a third-party evaluation team to conduct the field trial. The obvious advantage is that the evaluators test the system and analyze the data in a totally unbiased manner. The simulation designer, by this point, has a large stake in the success of his system, and unintentionally may allow bias to cloud his conduct, analysis, and interpretation of field-trial data. If such a procedure is followed, the designer should guard against rationalizing or defending negative findings of the evaluation. Rather, he should modify the system to alleviate these negative points.

Step 13. Make further modifications to the system deemed appropriate from field trial evidence.

When this point is reached, it is hoped that few "bugs" are found in the system as detected during the field trial. If the previous steps have been executed in an excellent manner, the field trial will indicate improvements, not major changes. In some instances, system components such as instructor's manuals and "packaging" may receive the majority of attention. At this time, the designer may also begin investigating ways to disseminate his system.

A Final Word

Sarane Boocock and E. O Schild state in their book on simulation games that

> "Game design is not only not a science, it is hardly a craft, but rather an 'art' in the sense that we have no explicit rules to transmit."
>
> (Boocock and Schild, 1968, p. 266)

Others have made essentially the same statement of media-ascendant simulation. With this position, these writers could not argue. Further, the guidelines offered above certainly are not the final word. Why, one glance at the list of variables of learning games presented in Appendix A of this report would suggest that many answers are lacking. The use of the systems approach to building simulation exercises is one step in the right direction, as meaningful research directions may be specified in the context of the development of simulation exercises.

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III. Instructional Simulation: Past, Present and Future

Paul A. Twelker

This chapter examines some rather old, as well as some recent uses of simulation in non-school settings, the military, government, and industry. Included are discussions of the implications of each use to education in general.

A function of the increasingly complex technological world in which we live has been the requirement for better learning systems -- systems where the student is actively involved in the learning process. Such an environment is learner-centered rather than instructor-centered. With the advent of simulation, the oft-quoted axiom that learners should participate actively in instruction is given meaning and substance.

The purpose of this chapter is to examine some applications of instructional simulation that will serve as "bench marks" for the reader as he assesses for himself the status of the field -- where it has been, where it is now, and where it might be going in the future. It should be stressed that this paper in no way attempts to survey exhaustively the many applications of simulation in school and non-school settings. The reader is referred to the annotated bibliography, "Instructional Simulation Systems: An Annotated Bibliography" (Twelker, 1969) for a more comprehensive listing of applications, and to Appendix C for some suggested new directions in simulation.

Instructional Simulation Applications

Most of the applications discussed pertain to instruction, and in particular, the provision of an environment for exercising or practicing the application of principles or skills. The instructional simulation systems to be examined all possess the following features:

(1) enacted or life-like responses are made to

(2) non-real-life stimulus situations that

(3) provide feedback to the student vis a vis his behavior in the on-going instructional context that

(4) offers control.

Simulation may be used for purposes other than instruction. In particular, the use of simulation in the generation of new systems or programs is important. The developmental use will be explored in the section on governmental applications.

Military Applications

Simulator Trainers. In the military, the word "simulator" is commonly associated with equipment. Often, these "machine-ascendent" simulators require a team of operators rather than just one, and are called "systems simulators." Many are multi-million dollar devices, and are mediated by an electronic computer. Some have estimated that there are over 3,000 different types of simulators used currently by the military and commercial aviation. Expenditures on prototype simulation devices are set minimally at $27 million annually. Listed below are several names of simulators that serve to illustrate the variety of training functions served by simulation.

Simulator, Small Arms, Flash Noise
Shipboard Universal Radar Land Mass Simulator
Sonar Simulator
Submarine Simulator, Universal
Talos System Shipboard Simulation Equipment
Target Generator, Three Dimensional, Airborne Simulator
Helicopter Flight Simulation
Height Finder Target Simulation
Fire Control and Launcher Simulation
F8U-1 Operational Flight Simulator Trainer

The evolution of computer-mediated simulator trainers has been significantly speeded by groups such as NASA in its efforts to provide a training capability for manual space flights. Most of these simulators represent a sophistication of man-machine adaptive and responsive environments. Kristy (1967) describes a training environment that staggers the imagination of those who spend most of the time in front of a chalkboard talking to students. The Simutech Trainer was conceived of to train Air Firce electronics technicians in a manner that provides tutorial teaching capabilities and realistic on-the-job experience. The specification of the system which Kristy describes calls for computer-controlled programed learning to integrate several types of display: (1) animated schematics, (2) textual and diagrammatic teaching material that includes quizzes and branching sequences. A high-speed, quick-access, videotaped presentation system provides informal lectures, "cookbook" advice, and tutorial support for the student. All this is linked with a simulation of an electronic system which the student is responsible for maintaining. This system, linked with the computer, senses and responds to the student's maintenance actions. Another component in the trainer system is a simulation of the "operations room" of an Air Force site. This is accomplished by a "squawk box" communication tie between the operator and the maintenance room. With this system, the student:

(1) can receive video instruction on fundamentals of electronics;

(2) can receive clarification and reinforcement from the computer-controlled programed instruction console;

(3) can practice what he has learned by performing "on the job" by means of the simulated hardward,

(4) can receive remedial help when he wishes or when the computer deems it necessary;

(5) can be quizzed on his progress;

(6) can proceed at his individual pace;

(7) can be monitored so as to inform instructors of his progress and difficulties to examine during small, live-group sessions.

From studies of the efficiency of computer assisted instruction and simulation training, it is estimated that training time may be cut by two-thirds using this equipment. If the system is implemented to accomplish electronics training in the Air Force, the cost would be about $130 million. Although this cost represents a huge sum, Kristy points out that if the trainers were capable of actually reducing training time by two-thirds, the Air Force would save a large fraction of the funds expended on training, and these savings would pay for the system engineering, hardware development, and installation costs of $130 million in only 18 months. Thereafter, the Air Force would save in training costs up to $75 million per year.

Auto-Instructional Simulators. In the military, simulation applications range from the exceedingly simple to the exceedingly complex. At one end of the continuum, a simulator may cost as little as ten cents, while on the other end of the continuum, one single simulator may cost as much as $11 million. The Simutech Trainer discussed above was a complex system that taught, among other things, the proper steps and procedures of trouble shooting (a cognitive objective) as well as how to actually carry out the task on-the-job (a cognitive/psychomotor objective). The former involved the teaching of certain decision-making skills, discrimination skills, problem-solving, and so forth. The latter involved the learner in using these skills on the simulated job which demanded physical manipulation. Although simulation may be used to exercise both types of objectives, the cost may vary tremendously. A class of auto-instructional devices termed Trainer-Tester Simulators that cover many subjects illustrate this admirably. For illustration, a motor trouble-shooting Trainer-Tester Simulator will be examined.

At the U. S. Army Ordinance School at the Aberdeen Proving Ground in Maryland, several courses require servicemen to remove, install, trouble-shoot and adjust six-cylinder engines. One way to accomplish this is to have a series of engines rigged to exhibit certain defects, and teach the servicemen the correct procedures to use in trouble-shooting and correcting the fault. Needless to say, this is expensive, and led Van Valkenburgh, Nooger, and Neville, Inc. to design the Trainer-Tester Simulator, an auto-instructional device that uses pictorial views, and specially designed worksheets. The Pictorial Review sheets are used in conjunction with the worksheets to familiarize the trainee with the location of various components, to show the interrelatedness of the components, and to assist the trainee in determining correct procedures to be followed in performing the simulated tasks given in the problems. The Trouble Shooting and Repair Worksheet includes columns that list a specific problem, a symptom section, and a corrective-action section. The data in the symptom and corrective-action sections are concealed by a silver overlay which is easily removed by using a pencil eraser. The data uncovered reflects deviations from normal operation with the equipment operating under the indicated trouble symptom. The trainee must be familiar with the equipment to select those checkpoints from which he wishes to obtain data so that he may arrive at a correct solution. Indiscriminate erasures indicate that the trainee has analyzed the problem incorrectly.

A typical trouble shooting problem for the six-cylinder engine is given as follows: "Breaking action is poor; break pedal has a soft, spongy action" or "Engine will not start and there is no spark at the spark plugs." Using the latter problem as an example, the trainee might reason as follows:

> "Well, it's apparent that the trouble is electrical in nature. Also the fault must not be with the batteries or starting motor since the motor turns over. Hmmm - let's check Figure 17 (the wiring diagram). Most likely, the fault is with the spark plugs or the distributor. Let's start trouble shooting at the spark plugs. (Trainee refers to pictorial reviews and part identification sheets, and finds that spark plugs are called out by the symbol letters AD. He then runs down the list of checkpoint symbols on the Trouble Shooting Worksheet until he comes to the letters AD and then erases the silver overlay adjacent to the letters and writes the number "1" in the Step column.) "Got a value of '0.030 end gap.' (Trainee checks normal value on supplementary information sheet.) That indicates the spark plugs are functioning normally and that's not the cause of my trouble. The fault must be with the distributor."

The trainee has just begun on his trouble-shooting mission. He has yet to examine the breaker points, the breaker-plate capacitor, distributor rotor, ignition coil, or distributor cap. Any of these five parts could be the cause of the trouble and has to be checked until the data obtained disagrees with the normal value of the part given on a supplementary information sheet. By the way, when the student erases the silver overlay next to the distributor cap, it reveals the word "cracked" which indicates that a cracked distributor cap is a possible cause of the trouble. He then moves to the corrective action column, specifies a part replacement and finds that the trouble is corrected and the problem has been solved.

The Pocket Blinker and War Wound Moulage Kit. Lest the reader get the mistaken idea that the lower the cost, the more limited the simulator, let us examine two ingenious techniques that represent low cost simulators. One costs about ten cents and is called a pocket blinker, and it certainly meets all of the requisites to be classified as a simulator (U. S. Naval Training Device Center, 1963). The device is cardboard, and simulates the operation of a ship's blinker. Two seamen, sitting across a table from each other, may practice sending Morse Code messages back and forth using two of these little devices. They are so constructed that hand pressure moves a sliding cardboard in and out of a slot, thus simulating the alternate black and white patterns emanating from a ship's blinker light.

The second simulation is the War Wound Moulage Kit, which represents relatively high fidelity but low cost -- the War Wound Moulage Training Aid (Wooley & Audet, 1956). The Wound Moulage serves two principal purposes: (1) it enables the wearer to apply first aid treatment to himself, witnessed by students for a firsthand demonstration of proper first-aid procedure, and (2) it enables the wearer to be placed in the field as a casualty, enabling students to perform first-aid measures under simulated battle conditions. Let us examine the latter of these two purposes. Place yourself in the position of a squad leader, walking through the woods. It is a hot day, and around you is the sound of war - artillery, grenades, rifle fire. This is a full scale, simulated, battle maneuver. You hear a call for help. Over to the left, a man lies wounded. You rush to him and apply first aid. Bleeding stops.

The wound that you "treated" was simulated. Yet, the situation called for real-life operations that sometime could save a man's life. The wound moulage consists of a thin flexible, flesh-colored overlay which simulates as closely as possible actual wounds in pertinent adjacent areas of the human anatomy. Each individual moulage is full size, depicts all of the characteristics of a wound, including details such as torn flesh, broken bone, severed veins and arteries, and even blood flow. Bone structure and flesh are shown in relief on the surface of the moulage. Each moulage is capable of being attached to the appropriate area of the wearer's body, and is readily removable without the use of tools. Included in the kit is a veinous puncture moulage and a hypodermic-needle insertion moulage to train students in withdrawing blood and injecting medication into the body. The kit contains 20 moulages, several of which are mentioned below:

(1) Gun shot wound of the palm of the hand;

(2) Phosphor burns of the hands;

(3) Second and third degree burns of the forearm;

(4) Compound fracture of the lower leg

(5) Amputation.

Implications to education. The Simutech Trainer, the Trainer-Tester Simulator, and the other techniques mentioned are but a few applications currently being used or investigated by the military. These and other applications are summarized in Table IV-1. What does the military think about simulation? The Arthur D. Little, Inc. report (1968, p. 13) states that:

> "The growing emphasis on cost/effectiveness in military training programs will result in much greater use of simulation training. NTDC personnel suggest that the use of simulation is in its infancy and that there may be almost total dependency on simulation in several training areas in the not-too-distant future. Typical areas which lend themselves to simulation techniques are cockpit and operational flight training, in-flight training, and training in electronic warfare and weapon systems.
>
> In order to teach personnel to operate in the conceptual, psychophysical environments of the present and those anticipated for the future, new technologies are used to simulate such environments visually. A simulator involves any one or a combination of the training environment, computing and associated simulation systems, and instructor station and display systems. Electronics and optics represent major elements in the fabrication of a simulator. However, the market is not limited to electronics and optics companies; industrial organizations having educational technology capabilities should realize a considerable share of this market."

Will the military experience in simulation be translated effectively to the education of civilians in school settings? Few simulators have been used in occupational education. The civilian application of simulator trainers is discussed in detail by Kristy (1967, pp. 118-122). In summary, several important points are made:

(1) The major area of application appears to be in large federal training and retraining programs;

(2) On-the-job training seems necessary for retraining efforts, but poses serious problems;

Table IV-1

Some Military Uses of Simulation

Simulation	Designer	Target Group	Description
Autospan	Human Resources Research Office George Washington University	Army	Autospan provides for learning a foreign language via automated programmed instruction with a simulated tutor.
Caisim	U. S. Army Logistics Management Center	Army	This simulation concerns several management problems involved in industrial manufacturing. The setting for the problem is the U. S. Army Arsenal with the mission of manufacturing the 107mm Recoilless Rifle.
Calogsim	U. S. Army Logistics Management Center Fort Lee, Virginia	Military and civilian Logistics Personnel	This simulation is designed to utilize "selective management" and "management by exception" techniques in the hypothetical setting of the U. S. Defense Department wholesale supply system. The students are trained in the use of a logistics simulation at the wholesale level.
Capertism	U. S. Army Logistics Center, Ft. Lee, Va.	Army	Capertism is based on the technique known as PERT (Program Evaluation Review Technique) and simulates management of a project in which interrelated activities must be accomplished for the attainment of the objective end.

Simulation	Designer	Target Group	Description
Cross-Cultural Communication Simulation	Human Resources Research Office	Military	This simulation is designed as a demonstration of cognitive American behaviors as reflected by six cross-cultural encounters with a foreigner.
Monopologs	The Rand Corp. Santa Monica, Calif.	Air Force	This simulation is designed to introduce players to the Air Force Supply System. The players practice inventory management and gain insight into inventory control problems.
Pocket Blinker	U. S. Naval Training Device Center	Navy	The Pocket Blinker is designed to simulate the signal device used by the Navy in transmitting messages from ship to ship.
Simulation Trainers	U. S. Naval Training Device Center, and other groups.	Military Personnel	Simulation trainers, which number over 3000, are designed to train military personnel in various techniques involving man-machine adaptive and responsive environments. Some representative types are the: Submarine Simulator, Universal; Helicopter Flight Simulation; Fire Control and Launcher Simulation; F8U-1 Operational Flight Simulator Trainer; and the Height-Finder Target Simulation.
Trainer-Tester Simulators	Van Valkenburgh, & Neville, Inc. New York, N.Y.	Military	The trainer-testers are designed to simulate actual mechanical problems involved in the use of various technical equipment. The user is able to trouble shoot, on paper, problems involved in radar systems, a six-cylinder motor, and other electronic devices.

Simulation	Designer	Target Group	Description
War Wound	U. S. Naval Training Device Center	Military Personnel	The moulages kit is designed to simulate in-battle emergencies by the use of plastic overlays. These overlays simulate torn flesh, broken bones, severed veins and arteries, and blood flow.

(3) A high-efficiency training system such as the Simutech Trainer can provide simulated "on-the-job" training;

(4) The application of the Simutech Trainer to the federal programs would occur simultaneously with its application in industrial training programs;

(5) The application of the system to vocational high schools has serious problems with respect to the large capital investment required.

Regarding the last point, Kristy shows that the cost of training students in an optimal installation in six to ten different technical areas might run $450 per trainee per year, figuring a 10-year period to amortize the capital investment. This is two or three times the average investment in training students. Do the benefits or potential of such devices as the Simutech Trainer demand such expensive training? Is it necessary to build a "simulator-trainer-tutorial environment" that even senses human actions to a sensitive degree and presents "diverse, alternative programed situations leading toward teaching and learning objectives?"

Probably not, at least for some types of objectives. The Trainer-Tester Simulator represents a low cost, but highly effective technique for teaching both identification skills and operational procedures. Note that these operations are at the cognitive level, and do not involve psychomotor skills per se. Of course, in the operational situation, the trouble-shooter would then be required to remove engine components, replace defective parts, and so forth. Yet, the simulator effectively shortcuts an inefficient and time-consuming trouble shooting operation if real equipment were involved at early stages of instruction. It is important that the trainee know what to trouble shoot, and in what order, before he actually begins the messy business of removing engine components and the like. These skills could just as easily be performed or practiced on the job. This illustrates an important advantage of simulation: When actual on-the-job performance would be costly or hazardous, use simulation. The Trainer-Tester Simulator is inexpensive to produce and is admirably suited for the educational objectives. What better way would there be to have biology students "practice" dissection before actually beginning the work. After reading the text, they could go through the procedure using a Trainer-Tester Simulator. Or the technique could be applied to medical education, where medical students would be required to diagnose certain problematic symptoms of a patient. This, in fact, has been done in the area of orthopaedic surgery, and will be discussed below.

Further, in a remarkable way, the pocket blinker illustrates the fact that simulation exercises or devices do not have to be expensive to be effective. As long as the educational objective is consistent with the operations demanded by the exercise, low-fidelity, low-cost devices are eminently satisfactory. Even if the objective for a seaman learning Morse Code is to have him identify patterns under adverse conditions such as bad weather or combat, variation in the way the pocket blinker is used could provide such training. However, for educational objectives that simply reflect the learning of the Morse Code and identifying visually Morse Code patterns, the pocket blinker used in the simplest circumstances is a suitable simulation exercise. Low fidelity, in this case, does not sacrifice learning effectiveness and efficiency. Similarly, simulation exercises and devices do not have to be expensive in school settings for many objectives.

Unfortunately, simulation designers, for the most part, have not been able to specify when exact physical duplication of the real-life situation is necessary to guarantee maximum transfer in the real-life (operational) situation. The research literature does not have a precise answer to this question. Some studies on transfer of training show that the more similar the two situations are, the more transfer will occur from the first situation to the second situation. On the basis of these studies, many designers are prone to develop what are called "high-fidelity simulations," some of which are so complex that entire teams of operators are required to monitor the experience. On the other hand, many studies have presented evidence to indicate that for complex skills, greater transfer is produced by a systematic arrangement of practice than by high-fidelity physical simulation (Gagne, 1962; Cox, et al., 1963; Gryde, 1966; Crawford, 1962; Smode, 1963; Newton, 1959).

A cursory examination of each of the four simulation applications described above -- the simulator trainer, the low-cost auto-instructional simulator, the pocket blinker and the wound moulage -- reveals that they share in common the feature of being media- or machine-ascendent. That is, each uses some mediating device to provide an opportunity for practice or exercise of various crucial skills. It goes without saying that complex decision-making or identification skills are probably best trained by exercising these behaviors in a life-like setting where the learner may receive immediate feedback as to the adequacy of his response. Civilian applications of media-oriented simulation are becoming increasingly familiar in higher education. An example is found in the unique application of simulation in teacher education as developed at Teaching Research (Kersh, 1961; 1963a; 1963b; Twelker, 1967). Classroom simulation creates for the student teacher many of the relevant features of a single classroom situation called "Mr. Land's Sixth Grade." Mr. Land is the hypothetical supervising teacher with whom the student teachers work during this simulated experience. A complete cumulative record file is available on each child in addition to printed descriptions of the hypothetical school and community. The technique of filming the youngsters in the simulated class so that they appear to be reacting to the student teacher during the sequences is employed in sixty different problem sequences on sound, motion-picture film. In each case, the student teacher is expected to react to the film as though he were in a real classroom. Classroom simulation is based on the supposition that exposition of educational methods or principles could be expected to help the teacher talk about teaching, but only classroom experience (simulated or real) could train the beginning teacher to teach. It has been suggested that classroom simulation in this form helps students practice the discriminating of cues that signal potential problems that require immediate attention, make decisions in simulated conditions without fear of censure or embarrassment, and to modify their behavior on the basis of this feedback (Twelker, 1967).

Classroom simulation materials may be designed for three uses: (1) transition training, (2) pre-service training; and (3) in-service (refresher) training. In the first use, when a teacher moves from one school to another, or from one type of school to another (e.g., from a suburban school to an inner-city school), he might profit from a simulation experience of the new environment. This training might include becoming acquainted with new students, faculty, curriculum, regional characteristics, and so forth. The second use has already been discussed. In the third use, teachers might profit from time to time from review-type training experiences that involve simulation. Topics might include classroom management and innovative procedures.

There are numerous other examples of media-oriented simulation in civilian education. Some are briefly discussed below. It should be noted that not all of these applications have been developed at this time. It is simply a matter of time before other applications are made in school settings of media-oriented simulation to create a realistic practice setting.

Teaching Problems Laboratory. These materials developed by Donald Cruickshank and others, and published by Science Research Associates, simulate an elementary school in which the participant assumes the role of Pat Taylor, a fifth grade teacher. The student practices solving critical teaching problems which are presented on film, through role plays and in written incident. The experience is intended to provide opportunities for students to examine their own motives and values.

Inner City Teaching Program. The program represents a revision of the simulation materials mentioned above, and recreates significant problems of teachers working in inner-city schools. The materials are being published by Science Research Associates.

Counselor Education. Beaird and Standish (1964) developed a simulated environment to train counselors to: (1) discriminate between cognitive and affective client response, and (2) use counselor response leads in ways to facilitate more client affective responses. The materials used pre-programed tape recordings that simulated the client, and provided a context for the counselor to practice the above-mentioned skills.

David Delaney of the University of Illinois has proposed that simulation materials be used to assist counselors-in-training to develop certain basic competencies such as: (1) reinforcing talking behavior in a nontalkative client; (2) increasing counselor's awareness of responding to clients nonverbal cues; (3) increasing counselor's effectiveness in working with a client who desires test-reinforcing support; and (4) shaping affective client verbal behavior.[1] The trainee would be reinforced via video-taped programs to emit appropriate response leads.

Music Education. John Gustafson of the University of Oregon has initiated the development of simulation materials for teaching preservice music teachers to manage the music class.[1]

Reading Methods. Carl Wallen of the University of Oregon has proposed that instructional simulation packages be developed to provide laboratory experiences in three major areas in elementary school reading: (1) recognition skills (grades 1-3); (2) understanding (grades 3-5); and (3) rate and study skills (grades 4-6).[1] Materials would consist of manuals and motion picture films, either 8mm or 16mm, and would be suited for either grouped or individualized instruction, with or without supervision. Other simulation applications in reading methods have been reported by Utsey et al. (1966).

Cross-Cultural Training. Jack Gordon of Wayne State University has proposed that simulation be used in realistic decision-forcing episodes interspersed among actual footage of situations typical to the educational environment of culturally different children. Adjunct materials might include: (1) films showing an exaggerated view of the new teacher as depicted by picture and stories of the children, (2) both beginning teacher blunders and experienced teacher moves that are unique to the particular group, and (3) a semi-documentary of the home life of a typical child with an interview with the parents portraying their attitudes toward education.[1] These materials would focus upon the similarities and differences one encounters when working with these groups. The simulations would provide a series of decision-forcing experiences which would illustrate the unique problems in dealing with culturally different learners. An especially relevant area of application might be in the orientation of new Bureau of Indian Affairs teachers in Alaska.

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[1] Personal communication.

Exceptional Child Care. Little is available in the way of training for hospital attendants for the mentally retarded. Crucial to this effort would be a job analysis of the attendant's job so that training objectives could be established.

Vocational Education. Simulation might be used to give students a "full-color" experience of relevant occupations. Students could be given a series of 50 or so simulated episodes, and then asked to choose five for an in-depth experience. Then students could go on to a work experience. In this way, students have an opportunity to see what kind of occupations are available, what they are like, what types of pressure exist on the job, how decisions are made, and so forth.

In a United States Office of Education-funded project to develop an Information System for Vocational Decisions (ISVD), D. V. Tiedeman and others have worked on two projects that may hold promise in this area. The project commissioned Abt Associates to produce the "Machinist Career Simulation" to help a student learn about careers of interest to him while learning about the abilities and preparation required. It was designed as a single-player manual simulation game that could be played by an interested junior high school student without direct supervision. ISVD plans to develop film cartridges to depict each of the alternatives open to an individual at each choice point. In doing this, it is hoped that the nonverbal impact of the system will be increased and made more effective with disadvantaged users in low-income school districts, Job Corps Centers, and employment offices.

In a second effort, ISVD is modifying the Life Career Game developed by Sarane Boocock. This game allows a player to exercise choice in school work, and leisure areas. The modifications include the incorporation of visuals, information data files, and revised scoring systems.

How important is it that simulation be adopted in education, particularly vocational education? If one examines the dropout rate, he will find that the nation loses a quarter or more of its youngsters as dropouts. It is difficult to say if these same individuals might be sufficiently motivated in an instructional environment that uses simulation to continue with their education. It is estimated that "if the present rate of dropouts continues, there will be 32 million adults without high school diplomas by 1975" (Arthur D. Little, Inc., 1968, p. 11). Experts have estimated that at least 25 million Americans should be receiving vocational training. Yet the number actually receiving training is closer to 8 million, leaving a vocational education gap of 17 million.

Indications are that there is rising concern over the steadily widening gap between the nation's manpower requirements and the capabilities of the available manpower pool. It has been predicted that "substantial" government support for manpower development programs will continue. How much is spent for civilian institutional training and on-the-job training? It is estimated that about $286 million for institutional training and $54 million for on-the-job training is spent under funding from the Manpower Development Training Act of 1963 (Arthur D. Little, Inc., 1968, p. 12). Even if the estimated $1.3 billion expenditure of Office of Economic Opportunity funds for equipment and materials in training programs are added, the total cost would hardly exceed $1.7 billion annually, while the training costs of the Department of Defense for military personnel total approximately $4 billion per year. It should not be necessary to say more about the comparison of where "substantial" support is going!

In summary, it would seem plausible that the application of complex simulator trainers will not be flooding our occupational education areas for some time. The factors that preclude rapid adoption center around three areas:

> Expense. Few schools have the capital to invest in these complex simulator systems, even if it were shown that training time could be drastically reduced and that the system could pay for itself in a reasonable period of time. It has been estimated that the cost to provide electronic equipment to one child per year is $250 *vs* $8 per year per child for texts (Arthur D. Little, Inc., 1968).
>
> Insufficient cost/effectiveness data. This might be the major problem with complex systems such as the Simutech Trainer in civilian applications. The very great cost advantage where high efficiency training is desired and economically necessary has yet to be proven.
>
> Slowness of acceptance. Educators are a conservative lot, and the supposed "dehumanizing of education" poses a threat to innovation. In fact, machine-ascendent simulation does not dehumanize instruction, but places in the hands of the student a learning environment that is quite similar to the operational world in which he will have to subsequently operate.

On the other hand, it is not implausible to expect that noncomputer instructional simulation systems will have a great impact in the near future. The reader is referred to the chapter on application of simulation to vocational education by Dr.Hamreus for a more thorough exploration of these matters.

Governmental Applications

To this point, little has been said of the application of simulation in settings that do not involve instruction. In the discussion of governmental applications of simulation it might be profitable to examine the use of an human-player simulation exercise for the analysis and planning of complex programs or systems. Other applications are reviewed in Table IV-2.

Typically, the planning of programs that involve complex situations where numerous points of view may be brought to bear takes place in rather sterile environments that do not allow the planners to use creativity and experience to detect unforseen difficulties, develop new strategies, and examine their effect on the proposed system or program. Sitting around a conference table may not always promote the kind of social interchange that is conducive to good analysis and planning. A special use of the simulation exercise normally reserved for instruction offers a great potential for educational planning. For purposes of this discussion, it may be referred to simply as a planning exercise. Planning exercises have found use in city planning, architecture, and urban development (Taylor, 1967; Taylor and Maddison, 1967, 1968; Feldt, 1966, 1967). Strategies for military efforts have been developed using war games. It is only natural that the application of the simulation exercise to planning be exploited elsewhere.

The planning exercise to be described for purposes of illustration was conducted for the exercise and evaluation of national-level civil defense systems within the context of realistic changes in international tension and crisis buildups (Hardick *et al.*, 1967). The exercise portrayed an environment that simulated the world in which the Office of Civil Defense (OCD) exists so that its functions and operations could be introduced into that environment for purposes of analysis and evaluation.

The game allows the OCD to:

(1) identify problem areas and alternative courses of action, given the initial situation;

(2) obtain information for further study and analysis;

(3) investigate alternatives and problem areas by actually "playing" them out;

(4) identify future possible contingencies, important operative factors, and probable outcomes that may be overlooked in OCD planning,

(5) stockpile useful conclusions from various plays and recycles of the game;

Table IV-2

Some Governmental Uses of Simulation

Simulation	Designer	Target Group	Description
Agile-Coin	Abt Associates, Inc., Cambridge, Mass.	Advanced Research Projects Agency	This game focuses on important political and operational factors in the transition from the terrorism phase to the guerilla warfare phase of insurgency. The objective of the game is to observe the effects of coercion and counter-coercion on village loyalty.
Forest Fire Simulation	International Electric Corporation Paramus, New Jersey	Division of Fire Control of the Forest Service, Dept. of Ag.	The Forest Fire Simulation is designed to provide training in a realistic stress condition associated with campaign fire management.
Corridor	Abt Associates, Inc., Cambridge, Mass.	U. S. Department of Commerce, Northeast Corridor Project	The simulation exercises political and economics factors which come into play in the formulation and implementation of regional transportation policy for an extended area.
Federal Market Place	Information Resources, Inc.	Higher Education; Administrative Personnel	Federal Market Place is designed to provide a simulated social environment in which people can learn about the process of Federal assistance for higher education.

Simulation	Designer	Target Group	Description
National Level Civil Defense	Technical Operations, Inc. System Science Division Arlington, Virginia	Office of Civil Defense	This simulation is designed to provide gaming experience for exercising and evaluating Civil Defense systems. The simulation is exercised within the context of realistic and credible changes in international tensions and crisis.
Office of Industrial Development (OID) Management Sim. Exercise	State of California Resources Agency	Department of Water Resources, State of California	Simulation exercise for training Department of Water Resources personnel in various management and administration problems
PESO	Abt Associates, Inc. Cambridge, Mass	Inter-American Development Bank	The game is designed to show officials from Latin American countries how to present requests for financing development projects. Trainees play lending officers in the institutions and ministers representing the economic sectors in need of financing.
Police Training	Abt Associates, Inc. Cambridge, Mass.	Law Enforcement Officers	The game is used to demonstrate that the relation between law enforcement officers and the community is not competitive but cooperative.
Politica	Abt Associates, Inc. Cambridge, Mass.	Advanced Research Project Agency	This game is designed to simulate the economic and political functioning of a nation by attempting to structure the roles of major interacting national groups, to place them in conflict of cooperation, and to identify from the resulting interaction the societal and human variables relevant to a study of incipient insurgency.

Simulation	Designer	Target Group	Description
Polwar	Abt Associates, Inc. Cambridge, Mass.	Foreign Service	This game is designed to present some of the political and economic factors present at the Village level in the current phase of the Viet Nam situation. It specifically focuses on the operation of the Vietnamese Revolutionary Development Program.
Region	Washington Center for Metropolitan Studies Washington, D.C.	Urban planners	This game simulates the growth of metropolitan areas and incorporates some of the theories of economics, political science, and sociology. The game consists of two regions: Region I is a simplified version of an urban area and Region II represents a highly complex group of urban systems.
Shelter Management Contingency Game	Social Systems Program, American Institutes for Research	Office of Civil Defense, Shelter Management Instructors	Presents complexities of problems found in the management of a large shelter.
Simpolis	Abt Associates, Inc. Cambridge, Mass.	Design-In	Simpolis is an encounter with seven major urban problems of transportation, education, housing, civil rights, poverty, crime, and pollution. The aim is to communicate the essence of the problems and elicit possible solutions to and consequences of the various problems.

Simulation	Designer	Target Group	Description
Virgin Islands	Abt Associates, Inc. Cambridge, Mass.	College of the Virgin Islands	This simulation is designed to demonstrate and clarify social communications problems in St. Thomas, while showing opportunities for improving this communication among Island groups.
Urbcoin	Abt Associates, Inc. Cambridge, Mass.	Advanced Research Projects Agency	The game exercises a number of factors important in situations of urban insurgency. The players interact in terms of population on "lives" so that terror can be simulated and also in terms of "money" so that economic disruption is possible.

(6) test probable impact of changes in OCD systems;

(7) identify weak links in OCD and other governmental agencies;

(8) provide "analytical guideposts" for future studies; and

(9) evaluate the impact of the exigencies of time and events on the OCD decision-making process.

In its simplest form, the game involves two sides:

(1) the United States, represented by the Blue National Team and the Office of Civil Defense (CD) Team; and

(2) the enemy, represented by the Red National Team.

The OCD Team operates separately as a subordinate staff agency of the Blue Team, and furnishes the Blue Team with status reports on civil defense activities, advises on civil defense matters, and converts Blue civil defense decisions into plans and orders. In a more complex form, the game may involve other nations.

A basic scenario provides the framework and background against which plans and decisions are made by the participants. In brief, it provides the setting for the initiation of game play. Factual data present general and special international situations to provide a view of the world conflict areas. Summaries are given to each team describing their national political and economic posture, their resources, national goals, and so forth. In addition, separate intelligence reports defining enemy capabilities, limitations, and resources are provided.

Once the basic scenario is used to project the world situation to the starting point of the game, player actions largely determine subsequent events and world conditions. A "control" is used to guide the game so it does not drift into irrelevant channels that do not meet the game objectives. The main feature in the game play is the "estimate of the situation" prepared by each team. These represent plans or actions derived from logical analysis of the events, and provide a basis for succeeding cycles of play when these plans and actions are implemented to generate international tension that precipitates a crisis. "Control" assesses the estimates to determine their relevance to game objectives, and their validity with respect to diplomatic, political, and military strategies. Succeeding cycles provide players an opportunity to implement the actions projected in their initial estimate, to analyze new situations, to develop alternative plans to meet the simulated conditions, and to make further decisions regarding their course of action to take.

Side studies may be used to examine in detail significant facets of a civil defense situation not amenable to full development during the exercise. Another important feature of the exercise is the capability to retrace the path of the game and to replay it from any desired point in order to investigate alternative strategies.

The post-game evaluation is a crucial part of the planning exercise. The game is reviewed to broaden the overview of all players and to provide the opportunity for cross fertilization of ideas. It may be decided to replay specified situations or to conduct side studies when required.

Implications for Education. The sort of exercise described above has been used in planning educational systems. Abt (1967) calls the technique a "human-player simulation of the planning, programming, and budgeting process."

Typically, the planning exercises developed by Clark Abt and Associates usually run for at least a day or two and involve as many as fifty or sixty participants. Simply stated, the exercise is "designed to force planners to interact with one another over critical school issues and to gain from the feedback, critical insight into the problems of educational planning and the possibilities for solution" (Abt Associates, Inc., 1968, p. 7).

Three variations of the planning exercises have been described in detail elsewhere: The Educational System Planning Game (Abt, 1967); the PEPEX Educational Planning Simulation (Abt Associates, Inc., 1968); and SEPEX - A School Electronics Planning Exercise (Abt Associates, Inc., 1967). The Educational System Planning Game involves the participants in a game situation where major issues of education planning, their benefits and their costs, are brought into the open and discussed. Players take the roles of educators, students, and a special type of person - the "Reality Daemon" whose function it is to personify various social problems and pressure groups related to educational planning such as industry, the disadvantaged, the minority groups, parent groups, and so forth. Depending on the number of players, there may be two or more teams composed of these three groups. The game exercises Educator Teams in their educational-system planning skills, and Student and Reality Daemon Teams in their education-evaluative skills as well as the identification of crucial issues. The Educator Team that prepares the best program, perhaps measured by the quantity and quality of graduates, with the given budget, wins.

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The sequence of activities may be summarized as follows:

(1) The Educator teams formulate policy while the Student teams prepare evaluative criteria for estimating the Educator's programs. The Reality Daemons input to both teams.

(2) The Educator teams submit their reports for Student team evaluation and selection.

(3) The Reality Daemons make adjustments for implausible claims, and score the evaluations.

To be sure, the plans produced in a few hours' deliberation are much too broad to be directly useful. Yet, it seems evident from this writer's experience with the planning game that successive cycles of play, perhaps separated by information-generating activities, may be a very real asset to the planning of educational systems. In a realistic and intense way, issues are brought to light, and various strategies of meeting these issues are proposed and evaluated. The interpersonal communications that are elicited in the simulation environment seem to have a facilitative effect in focusing the problem and bringing to light tentative solutions, much more so that in a discussion of the same problems around a conference table. An added bonus is that the exercise is readily adapted to practically any educational group's needs, and little is required in the way of special facilities or equipment.

It remains to be seen whether the planning exercise actually does result in better program plans consistently as compared with contentional techniques. Evidence in the published reports indicate that local conditions or inadequacies in previous plays lead to changes in the exercise that may or may not represent improvements (cf., Abt, 1968). Game design questions need to be resolved: How complete should the briefing be, in terms of school district data and information; how precise should roles be defined; how much time should be given for the various activities; what terminal objective should be stressed (prepare a finished plan vs. state problems and suggest solutions); how much game structure should be used; how many issues should be predesigned into the game; how much role-assuming vs. role-performing behaviors should be used, i.e., should superintendents perform their own role, or another's role; etc.

In summary, it seems that the planning exercise offers some exciting alternatives for constructing programs in the field of education. Its potential has not been realized. It has even been suggested that "ultimately, a planning exercise should be used to assist planners in building predictive models of the educational systems for which they are planning" (Abt Associates, Inc., 1968). This use of simulation should receive much greater attention, both in application and research, in the next few years.

Industrial Applications

Many industries and businesses have grown so rapidly in the last decade that training programs for their employees are practically mandatory. Personnel shortages in some areas are acute. Management has recognized the need for having training programs in order to retain talent as well as to upgrade talent.

Typically, these programs initially emulate conventional programs found in public education. The immediate problem that faces the vice president in charge of training is that when managers, employees, and businessmen return to the classes, the last thing they want are seminars and lectures on fundamental principles and concepts isolated from a functional context. This problem is easily overcome with the use of simulation in the form of the business or management game.

Business games have historical roots dating back to war games and military map exercises (Thomas, 1957). In the typical military game, two teams given hypothetical missions attempt to accomplish their goals by alternately making decisions, having them evaluated by umpires, and making further decisions on the basis of the umpires feedback. Often, computers are used to calculate the decisions.

The first practical game for business management was developed in 1957 by the American Management Association. The Top Management Decision Simulation is now one of hundreds of games that simulate the decision-making process of management in various settings ranging from supermarkets to unspecified industries. These games exercise all aspects of management including production, marketing, and inventory control. While many of the games are used in colleges, a wide variety are used in industry, for example, to help employees practice making decisions in business so as to better understand business operation. Such a business simulation exercise is Venture, developed by the Proctor and Gamble Company (Proctor and Gamble, 1966). In Venture, one or more participants manage cooperatively one of five companies, competing in a single consumer products industry. The exercise involves each company in making decisions about such things as production, costs, research, and marketing during an "operations meeting" and profit allocation during the "profits meeting." Scorers calculate manually the results of each company's decisions after each meeting.

Results are shown in terms of product sales, sales income and gross profit. After the six-period operation, a critique is conducted where participants review their objectives, decisions, and results.

Venture is geared more for the orientation of company employees to business operations than for the training of top management. The Proctor and Gamble Company has found it profitable to have employees learn more about what business management does. It should be noted that only selected parts of the industry are simulated. Not included are provisions for borrowing capital, for example. The omission reduces complexity as well as "serves as a constructive discipline toward participants' good management of existing resources." Other management simulations are geared for executives. Whatever audience is targeted, the game is basically similar to the one described, in terms of the decisions required.

Other applications of simulation in industrial or commercial settings are reviewed in Table IV-3. These are but a few of the more than 200 different applications that are now in use.

Implications for Education. Basically, the business game is a "trial-and-error method used to gain insight into business problems" (Greene, 1960). It may be used at the beginning of a training program to orient or sensitize students, or it may be used at the end of the course as a self-evaluative instrument. It can be played over a prolonged period of time, or in a matter of hours. It may even be played by mail. Greene (1960) reports of a large oil company whose men in the field report decisions, and review feedback by mail.

It need not be pointed out that the simulation game may be applied in education. It is being applied. Literally hundreds of games are being used, and have been used in past years with little public recognition. Although simulation games have great application in social studies and related areas, they are by no means limited to these areas. For example, the School Health Education Study group[2] has outlined several possible gaming areas in health education, including: growth and development (e.g., mating individual potential with job); man, disease and environment (e.g., decisions to take or not to take health actions); and mood-modifying substances (e.g., social influences on use). The work of the Information System for Vocational Decisions (ISVD) group has included the development of an achievement motivation development game that allows a student to experience the effects of realistic goal setting, moderate risk taking, use of feedback, and assuming responsibility for the initiation of action. A personal change script is being developed which allows the inquirer to specify a goal, plan various strategies for its attainment, periodically assess his progress, and use this feedback to reformulate his goal.

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[2] School Health Education Study, 1507 M Street, N.W., Room 800, Washington, D.C. 20005

Table IV-3

Some Industrial Uses of Simulation

Simulation	Designer	Target Group	Description
ADMAN	Abt Associates, Inc.	American Institute of Banking	This game describes problems faced by bankers in allocating advertising expenditures. The object is to acquaint bankers with advertising.
Drivocator System	Aetna Life and Casualty Company	Greyhound Corp.; Air Force; Public Schools	The Drivocator is a programmed simulation of actual situations which drivers may be faced with under normal driving conditions. The students are asked to respond to these situations by choosing the most logical course to follow.
Bank Loan	Abt Associates, Inc. Cambridge, Mass.	Banks	This game was developed to demonstrate management training in the making of loans.
Bristol	Abt Associates, Inc. Cambridge, Mass.	Bristol Laboratories, Division of Bristol-Meyers	This game is designed to familiarize district and regional managers with marketing strategy and marketing division operations.
Capital Budgeting	Abt Associates, Inc. Cambridge, Mass.	Price Waterhouse & Co.	The game provides a situation in which players can use such investment techniques as discounted cash flow, pay-back, and return on investment. The game also provides players with the circumstances where these techniques may be properly applied.

Simulation	Designer	Target Group	Description
Fast	Abt Associates, Inc. Cambridge, Mass.	U. S. Trust Co.	The game designed to explain to new trainees how the U. S. Trust Co. functions to attain basic corporate goals. The game demonstrates how interpersonal coordination is necessary in analysis, communications, planning, etc., to accomplish basic functions of the corporation.
IFMA	Abt Associates, Inc. Cambridge, Mass.	International Food Manufacturers Association	This game consists of three parts, each dealing with an area of specific interest to the food service industry. Part I concerns organizational development; Part II deals with selling national accounts and related distribution problems; Part III concerns mergers and acquisitions.
Purdue Dairy Management Game	E. M. Babb and L. M. Eisgruben	Industry and Schools	The game simulates the environment of competition in which two to four dairies are processing and marketing fluid mild products.
Purdue Farm Management Game	E. M. Babb and L. M. Eisgruben	Industry and Schools	This game simulates the environment in which a farm business must operate. Success depends on the correct combination of products to be produced, the correct method of production, and adjustment to changing conditions.

Simulation	Designer	Target Group	Description
Purdue Farm Supply Business Game	E. M. Babb and L. M. Eisgruben	Industry and Schools	This game is designed to duplicate the problems of the farm supply business. Managers must make operational decisions which are dependent upon available storage space, inventory, and anticipated sales with regard to competitors.
Purdue Supermarket Management Game	E. M. Babb and L. M. Eisgruben	National Assoc. of Retails Grocers of the United States.	This game simulates the environment in which supermarkets must operate. The managers gain experience in using business planning, analytical tools and economic and accounting principles.
Settle or Strike	Abt Associates, Inc. Cambridge, Mass.	Communication Workers of America	This game is designed to be a collective bargaining game for Union leaders of small shops to introduce them to the collective bargaining process.
Small Business Executive Decision Simulation	Bureau of Business Research, University of Texas	Small Business Administration	This simulation is designed to portray the competitive and operational environment confronting a small manufacturer. The manufacturer must make rational decisions concerning pricing, output, borrowing, and purchasing
Super A, Super B	Abt Associates, Inc. Cambridge, Mass.	Supermarket Institute	Super A is designed to teach supermarket buyers scientific buying techniques. Super B teaches supermarket executives how to make better decisions on trading stamps, introduction of soft goods, leasing of property and civil rights.

Simulation	Designer	Target Group	Description
Travelers Management Decision Game	The Travelers Insurance Co.	The Management Conference	This game simulates the operations of four insurance companies for a period of seven years. Decisions must be made relative to allocation of available funds, underwriting and maintaining margin of net profit.
UCLA Executive Game	Richard C. Henshaw James R. Jackson	Industry and Schools	The game simulates the various decision-making problems faced by executives in business. It covers the areas of production, marketing, finance, competition, etc.
Venture	Proctor & Gamble Co. Cincinnati, Ohio	Proctor & Gamble Co. personnel; Schools	Venture is a business simulation exercise designed to help develop a better understanding of how business corporations function. The players are introduced to the problems of conceiving, manufacturing, and marketing products.

To cite a third example, Ilajean Feldmiller of Youngstown State University has developed simulation games in the area of home management. Other applications of simulation games outside of social studies are reported by Twelker (1968b) and in Instructional Simulation Systems: An Annotated Bibliography (Twelker, 1969).

There are those who state that games have severe limitations, and are probably overused. Several years ago, the same type of criticism was given of business games (cf., Roberts, 1962). Now it's the educational game's turn to be criticized, and these criticisms are not entirely unfounded. It may be granted that its use has some of the characteristics of a fad. Many instructors are experimenting with the simulation game with little or no guidance offered by the game designers. Insufficient attention has been given to the realism of the game. Little time is devoted to insuring the competency of the game administrator, usually a teacher. It almost seems that the production of games with built-in shortcomings exceeds research on how games may be improved. Game design is either looked upon as exceedingly complicated, and difficult for laymen to understand, or it is a task handed over to the students themselves. Some point to this latter case as being the strongest asset of a game. When students design games, they learn about the model and how various components interrelate with each other. It's difficult to justify the building of elaborate guidelines for game design by the instructor when it is proposed that games be designed by the students themselves. Yet, youngsters may have more insight on the "whys" of student designed games than the instructors who design games for them. When asked whether he learned more from moving pictures or learning games, one junior-high schooler quickly replied, "Movies. They teach you something. Games are just for fun." Perhaps game designers have been too concerned with cognitive outcomes of the so-called learning games. Perhaps on occasion they should settle for affective outcomes that simply keep the potential learning dropout in the system. If a game did just this, it would be worth while. It is obvious that the game does possess enormous potential when properly applied. It involves most students actively where other techniques fail. Most users point out that the novelty and the excitement created by simulation are unparalleled in most educational circles. Cherryholmes (1968), in his review of six investigations of educational games, concluded that simulation produced increased student interest.

Innovative Applications

Television-Mediated Simulation. Simulation need not be limited to a trainer, a classroom, or a series of rooms in which students interact in teams. One of the most unique experiments involving simulation used home audiences of WGBX-TV, a special service UHF channel in Boston (Lee, 1967; 1968). In the fall of 1967 a 5-program simulation game, called The Most Dangerous Game was broadcast. It was a fictional-name simulation of the Korean crisis of 1950. Studio participants represented statesmen of six major nations involved in the simulated dispute. The home audience took the part of the political elite of one of the teams. They advised the statesmen through telephone calls and letters. Further, home viewers interacted with each other and discussed issues raised in the simulation.

Roger G. Mastrude of the Foreign Policy Association, with whose cooperation the series was developed, summarized the goals of the experiment.

> "(1) to enlist a new participating audience not enlisted through proper community-organizing efforts;
>
> (2) to motivate a relatively large audience of intelligent television viewers sufficiently to: (a) induce them to view a world affairs program, and (b) induce them to act as participants in simulation by interpersonal discussion and/or by telephone to the station;
>
> (3) to reshape simulation into a visual medium (for its normal character as a process wholly constructed for the experience of the players who enact it);
>
> (4) to construct a learning-situation fruitfully combining the 'media' of the simulation exercise, television, discussion, and telephone feedback;
>
> (5) to communicate substantive lessons with important educational value for this audience."
>
> (Lee, 1967, pp. 11-12)

The results of the experiment have been reported in detail elsewhere (Lee, 1967). For purposes of this discussion, it is sufficient to note that audience response was overwhelming. By far the most appealing aspect of the program reported by home viewers was "audience participation." Sixty-nine per cent of the audience called the station more than once on the last program. It is also interesting to note that the majority of viewers watched the program (or more accurately, participated in the simulation) as family groups or with informal groups.

Implication for education. This unique experiment represents a most significant wedding of a technique with a medium. There is little doubt the success of The Most Dangerous Game will not be forgotten. It revealed that television audiences need not be passive receptors. The experiment dramatically illustrated how television can involve home viewers.

In the experiment, the home audience played the role of advisors to one studio team. Clearly, this limitation did not reduce home participation involvement. However, the home participants need not be limited to an advisory role for only one team. Lee (1968) suggests that the simulation might be played in several cities, each city representing a country. Through a flexible interconnected network system, cities could break away from the interconnection and broadcast locally to only its own constituents. This, in fact, has now been done.[3] Cabinets in Crisis, a simulation involving the 1950 Yugoslav crisis with Russia, was played in the Spring of 1968 in three cities -- Boston, Philadelphia, and Rochester, New York. The studio audience took roles of executives while the home audience acted as the legislature who sent back replies to the executives to try to influence them. It was played for one day per week for five weeks. This same game has also been played with English speaking high school students in Singapore, Kenya, and Chicago.

The use of television as a medium for simulation need not be limited to international relations and world affairs. What better use could be made to involve all parts of society in an examination of urban problems, civil rights, and educational and local issues. For example, in an examination of poverty, could home viewers develop empathy with real-life counterparts in such a manner that their behavior would be permanently changed? Since television is so universally watched and enjoyed, the implications of using television, not as an information-imparter, but as a response eliciter, are staggering. What better way is there to unite a family for an evening in a school-related simulation in U. S. History, civics, or social problems. Simulation exercises need not be limited to class hours in a school room. The day might even come when periodic simulation specials are conducted over networks in prime time spots.

Situational Response Testing. In designing the form of a test, an individual has a number of possibilities available to him, such as:

(1) elicit a related behavior that must be inferred on the basis of logical relations;

(2) elicit "what I would do" behavior, where the student states what action he would take to solve a problem, given a brief description of a problem situation;

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[3] Personal communication with Mr. George McClelland, Foreign Policy Association.

(3) elicit lifelike behavior, where the student gives lifelike responses in non-real-life (simulated) settings; and

(4) observe real-life behavior.

These and others are discussed in detail by Frederiksen (1962, pp. 323-346).

Frederikson states that the "observation of real-life behavior is ordinarily not a suitable technique for measurement." (Nor is it usually practical, especially with large groups of learners.) Frederikson claims that the measure that is "recommended for just consideration in a training evaluation study is the type that most closely approximates the real-life situation."

For illustration, let us examine the work of the American Board of Orthopaedic Surgery, who has revolutionized its in-training examination with a procedure that simulates the physician-patient encounter (University of Illinois, 1967). The Patient Management Problem test has several unique features:

(1) It presents a simulation problem in patient management that carries the examinee through a series of sequential, interdependent decisions representing various stages in the diagnostic work-up and management of a patient;

(2) it provides realistic feedback about the results of each decision as a basis for subsequent action, and does not allow the examinee to retract his decision once it is made; and

(3) it allows both for variations in medical approaches and in patient responses appropriate to several approaches.

The procedure may be best illustrated by going through one of the problems. For example, one case involves a 62-year old woman who fell and fractured her hip. A mild cardiac failure was detected and controlled. The examinee is now asked to specify treatment of the fracture. Pictures of the fracture are provided. First of all, the examinee is asked to choose among six alternatives. Should he: (1) initiate non-operative therapy; (2) perform a closed reduction and internal fixation; (3) perform a closed reduction, valgus osteotomy and fixation; (4) perform an open reduction and internal fixation; (5) insert a prosthetic replacement; and (6) remove the femoral head and neck. The examinee indicates his choice by erasing an opaque overlay on an answer sheet to the right of the corresponding number of the choice. Suppose he chooses "to perform a closed reduction and internal fixation" and erases the overlay next to #370. He is directed to "Erase Response 445@ which reads:

> "After two attempts at reduction, X-rays were obtained. (Figures 5 and 6.) Turn to Section III E."

Section III E asks the examinee if this is an acceptable or unacceptable reduction, on the basis of the X-rays. If he says that it is acceptable, he erases the overlay next to #397 and is directed to "Erase Response 447."

> "You have now fixed the fragments and the patient has done well on your immediate post-operative regime. She has returned after two months complaining of pain in the groin. Upon examination the pain increases when the hip is moved in any direction. Turn to Section III A."

Section III A asks what the examinee suspects is wrong. Suppose he hypothesizes that loss of position is the cause of the pain. Erasing the #377 overlay reveals that $450 should be erased. It reads

> "You order an X-ray (Fig. 13) to confirm your suspicion. Turn to Section III 1)."

Section III D asks the examinee to advise one of several solutions. If he chooses full weight bearing as the treatment, he is asked to erase #389 and #457 consecutively, and reads:

> "In six weeks you receive a letter from another orthopaedic surgeon stating that the patient had consulted him because she had severe pain. He found that the femoral head had separated from the femoral neck and he is doing indicated reconstructive surgery. END OF PROBLEM."

It is apparent that an unwise decision a few moves back has led our future orthopaedic surgeon to strike out. The treatment of full weight bearing has caused further problems resulting in reconstructive surgery. His score for this problem is figured by noting the number of errors at failing to select helpful options as compared with the number of errors of selecting harmful or inaffective options. Also, his score could be expressed in terms of per cent agreement with the experts.

Other examinations employing simulation techniques that have been developed for the evaluation of performance in medicine include simulated diagnostic interviews, simulated proposed treatment interviews and simulated patient management conferences (Levine and McGuire, 1968; McGuire, 1968; University of Illinois, 1967a; 1967b). These techniques all use role-playing techniques, where an examiner is "programed" to play the role of a patient.

Implications for Education. A most urgent need in educational systems is for the criteria test that is given after instruction to accurately reflect the objectives of instruction. It is all too obvious that one cannot specify the appropriate techniques for evaluating instructional outcomes until he has a clear idea of what these outcomes are. During the last decade, the emphasis on stating objectives in a way that is at least related to observable behavior has given impetus to the designing of tests that better assess terminal performance on the part of the student.

In his discussion of situational response tests, Frederiksen uses as examples the Medical History test used by some medical schools, the In-Basket Test, used in school administration courses, the Russell Sage Social Relations Test, used to evaluate elementary schools with respect to their success in teaching "social relations," and the Physical Science Study Committee Physics Test, for high school physics courses. It will be noted that there is more than a passing resemblance of this technique with the Trainer-Tester Simulator discussed above. Both involve an ingenious method of sequencing a number of interdependent decision-points in a realistic manner so that the cognitive skills of decision making are exercised or tested. The potential for application in professional education courses, adult education, as well as in public schools is practically unrealized. There are some inroads being made in the area. For example, Jesse Garrison and Bert Kersh of Oregon College of Education are currently developing an instructional system of testing and interviewing using simulation that shows great promise as a means of assisting future teachers in their efforts to develop an appropriate and effective teaching style. The testing procedure employs classroom simulation films as test stimuli. The use of simulation for testing and performance evaluation is discussed further by Gagne (1954, 1962); Thorndike (1947); Gibson (1947); Schalock, et al. (1964); Plumpton (1964); Parker (1957); Lindquist (1950); and Beaird (1967).

Summary

From the examination of the several applications discussed above, it is probably safe to say that simulation is "coming of age." The "innovation" of simulation is not new to education, at least non-public education. Simulation has been around for years -- in the military, industry, and more recently, government. Simulation does not really represent a startling new approach that out-modes all others. It does represent a new way of looking at instruction that emphasizes the judicious approximation of aspects of real life to create an environment for life-like response on the part of the student.

How does one assess the status of the field? By the quantity of simulations being developed? By the quality of these products? By its wide range of application? This report does not purport to offer evidence to determine accurately any of these factors. It is difficult to even estimate how many different simulation exercises have been developed for instructional uses. It is also difficult to assess the quality of these simulations, since objectives are not clearly stated in many cases. It is somewhat easier to assess the variety of the application. One only need witness the applications briefly alluded to in this paper to see its wide use. Slowly, data are being accumulated to show the learning functions most appropriately developed by simulation techniques. In the next ten years, what will be learned about simulation will establish a firm data base to guide the development and use of the technique in well-founded ways.

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IV. Simulation Applications in Vocational Education

Dale G. Hamreus

This chapter examines some of the major problems currently present or emerging in vocational education and explores some of the implications of simulation to these problems. Examples of applications of simulation in several broad areas of vocational education are proposed, representing both newer media and gaming modes.

Education at all levels in the United States is currently undergoing intensive study and overhaul. For over a hundred years education has been aimed almost exclusively at academic arts and sciences. The current thrust is to tailor more education programs to the needs of the majority of students who never graduate from college. These are the students who need to be trained in work skills and prepared for the work world.

The Director of Vocational Education in the State of Oregon recently stated that Oregon's public schools today enroll about 68,000 junior and senior students; however, vocational education programs are available to only about 17 per cent of these students. He added that although the state total is more than 158,000 students, in the seventh through tenth grades, only about ten per cent of them are able to take advantage of vocational-technical education. He went on to estimate that within the next ten years, career development vocational-technical courses will become available to about half the state's juniors and seniors and about 75 per cent of the seventh through sophomore grade level students.[1]

Although scientifically measured data are not available regarding learning styles of vocationally oriented youths, the evidence that can be mustered strongly points to the fact that these students are fundamentally action oriented. This is particularly true of the ghetto child whose environment has educated him through experience rather than verbalization. Yet the school rewards these learners for their ability to verbalize in the same manner as it does college bound youths. The point is that as long as the school continues to force vocational oriented youngsters to sit and recite words unrelated to their background experiences, these youths will continue to become frustrated and lost to education and as a result inadequately prepared for meaningful work.

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[1] Personal communication with Dr. William Loomis, Director, Division of Community Colleges and Vocational Education, Oregon State Board of Education, Salem, Oregon

There is little doubt that vocational bound youngsters can learn the content of general education if learning activities and relevant communication skills are properly brought together. The school must motivate these less verbally gifted learners by engaging them more in doing, making, and creating. However, as should be apparent from the above comments, unless schools develop techniques other than the traditional verbally oriented ones they will continue to "turn off" a significant portion of vocationally directed youths and provide, at best, a weak and perplexing learning environment for a large number of these youngsters; this latter as evidenced by a variety of symptoms ranging from under-achievement to college dropping out.

Education for these learners must provide considerably more material in concrete rather than abstract form, and must allow for more manipulative demonstrations of skills rather than just verbal ones. In the words of Marvin J. Feldman (1967),

> The learner must see benefit, usefulness and advantage to himself in the subject matter and must have evidence that he can achieve in it . . . He wants the subject matter in action, functioning as part of real life whenever possible. To meet this requirement teachers must select methods which permit concrete and practical presentation of subject matter. Demonstrations, illustrations, visual aids, dramatizations, and the extensive use of projects and problem solving would aid in meeting these needs.

Educators must learn to develop and utilize newer methods and techniques such as simulation which will permit teachers to more adequately meet the needs of youth in fulfilling diploma requirements and acquiring salable skills.

Even though differences exist among the many states in the United States the above statements probably apply fairly well to the nation as a whole. What all this means is that within the next ten to fifteen years, major shifts in current practices of vocational education in the United States must and are going to take place. Of course many problems will be related to these major shifts. For example, (1) the changes in vocational education are going to cost a lot of money; (2) a vastly greater number of qualified vocational-technical teachers will be required (3) teacher preparation institutions will have to change their emphasis with less on teachers prepared in social and physical sciences and arts to more on teachers capable of working with non-college bound students; and (4) new vocational education curricular programs having relevance to the learner must be developed and articulated with business and industry and professional agencies.

Although the purpose of this chapter is to discuss the applications of simulation to vocational education, brief attention will first be given to each of the above four problems. The concern is to place simulation in better perspective to the problems of vocational education such that the reader can perceive more clearly the implications of applying simulation.

(1). Cost of vocational education. Any improvements to education cost more money. However, if shifts as predicted above are to take place in vocational education to handle the increased numbers of vocationally bound youth, even modest improvements will call for greatly increased costs. The object, of course, is to achieve these improvements with the least possible dollar expenditure. Simulation offers a powerful technique for improving both the effectiveness and efficiency of instruction. Through well designed applications of simulation employing the newer forms of media, not only can more learners be provided better instruction in less time, but more effective utilization can be made of high salaried master teachers. The rationale for this is simply that applications of simulation permit more self-learning opportunities as well as to provide situations where qualified but lower salaried teacher assistants and aides can be appropriately used. The combination of these conditions can result in improved cost-effective ratios to vocational education.

(2). What about the need for more qualified teachers? Simulation in and of itself will probably not reduce the total numbers of teachers required to provide quality instruction to the increasing numbers of students needing vocational preparation. It will, however, likely influence the proportion of master teachers and support personnel required, which has a direct relation to cost as was pointed out above. In other words, well designed simulation systems provide increased and improved methods of information transmission which require primarily only technical level trained persons to monitor the systems. This has the effect of releasing master teachers from many of the time consuming tasks they have traditionally performed since these tasks are better performed by the mediated systems. At the same time, such simulation systems permit the master teacher to engage more in uniquely human interactions with learners which are vital to the teaching of values, attitudes and broader meanings.

(3). The third problem is concerned with teacher training institutions shifting their emphasis to the preparation of more vocational teachers. This obviously will involve complex problems of curricular organization and planning. However, the implication of this problem to applications of simulation is that teacher preparation institutions can employ simulation as a means to improve their own teaching effectiveness of new vocational teachers and at the same time handle more teachers. They can, in addition, teach future vocational teachers the concepts of simulation and the skills needed in its application in instruction.

(4). The implications of the fourth problem to applications of simulation are the principal reason why this chapter has been written, i.e., the application of simulation in developing vocational programs. However, the issue of articulation with business and industry is somewhat of another matter. To the extent that vocational education programs can prepare their graduates to enter the world of work with little or no extra training required by the employing firm, effective articulation occurs. Present graduates of vocational education programs frequently require considerable in-plant training before they can become productive employees. Simulation offers a powerful tool for improving this articulation by providing a means for increasing the realism of training. In other words, the extent to which simulated training programs reproduce actual work situations, the greater the degree of transfer of training to the job that can take place. This, in turn, will increase the articulation between school and job.

Obviously, trade-offs in terms of costs and degree of realism in simulation must be considered in striving for optimum articulation; e.g., although the Simutech Trainer, described in Chapter III, is apparently quite effective in preparing learners with specified job skills, its attractiveness to schools would probably diminish rapidly as soon as they became aware of the high per-learner costs associated with its adoption. A less sophisticated simulator at considerably reduced costs, even though losing some degree of training effectiveness, would be much more desirable to the schools. The challenge is to build a cheaper simulator. In this regard, use of media can provide tremendous advantages.

Consider the cockpit trainer simulators that have been traditionally used with such great success in the U. S. Army aviation school. The cost of only one such electronic trainer designed to teach cockpit procedures for the OV-1 Mohawk aircraft was estimated to be $100,000.[1] Although this might be considered by some to be a relatively small cost, particularly when compared with the approximately $130 million price on the Simutech Trainer, it still represents a substantial cost to local school districts that would prohibit any widespread adoption. In contrast, however, is a $35 filmed mockup trainer[1] which is reported to teach normal cockpit procedures equally as effectively as the more elaborate and expensive electronic trainer. Thus, through the application of media enormous dollar savings were realized without any loss in training effectiveness. The point here is that virtually every school building has the means to support the applications of simulation in this latter form.

Even though only limited discussion has been made regarding the above four problem areas, it appears obvious that applications of simulation in vocational education instruction with an emphasis on media offer desirable advantages in obtaining the best instruction available for the money spent.

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[1] What HumRRO is Doing. The George Washington University, Vol. 5, No. 3-4, Spring-Summer, 1968.

The remainder of this chapter will be devoted to examining various applications of simulation and gaming to vocational education. Examples will be given to specific instructional problems in vocational areas of home economics education, health education, business education, trades and industry education, distributive education, and technical education.

Home Economics Education

Home economics education prepares students for the vocation of homemaking and wage-earning through the development of those understandings, abilities, and attitudes which are required in homemaking roles and service occupations related to home economics.

Child-Care Problems

Consider the application of simulation to child-care problems for secondary school home economics students.

Despite the fact that increasing numbers of high school girls are preparing themselves for college education, a large segment of the high school population will not enter into formal education beyond the high school level. For these students the secondary school represents the terminal level at which formal instruction is given to prepare them to live productive lives. One aspect of this instruction is the general area of preparation for family living and child-care. Most home economics courses in the high school offer some preparation in these areas. This instruction, however, is normally verbal or passive viewing of motion pictures and does not include opportunities for those who will rear or help to rear children to actually experience more direct child-care involvement requiring the making of decisions in response to specific types of situations or problems. Only minimal amounts of classroom instruction is provided that is relative to human growth and development patterns with little or no attention paid to the personality development of children.

Since it is difficult to include actual controlled experiences with children for secondary school students, other means must be found which will permit these students to learn and practice appropriate ways to handle the myriad of problems which they will confront as parents, attendants in day care centers and/or as homemaker employees. Simulation becomes a means of providing such experiences for this group of learners within senior high school level home economics classes.

Following the simulation techniques developed by Kersh (1963, 1965), a series of twenty problem sequences, each of which is portrayed on colored motion picture film depicting different types of child initiated situations, could be prepared. These filmed episodes should include child-care problems dealing with such areas as habits of hygiene, feeding, putting children to bed, playtime, accident prevention, group interactions, signs of illness, and temper tantrums. With each problem sequence a two or three episode filmed feedback sequence could be prepared which would portray typical child behavior likely to follow various types of adult reactions to the problem situation.

Behavioral criteria would have to be developed to judge the adequacy of students' responses. Criteria could be based on the opinions of home and family life experts, parents and psychologists, and would need to take into account the range of alternative behaviors considered to be equally effective in each situation.

Two criterion measures could be developed: (1) a performance test with motion pictures of child-care problems sufficiently different from those used during the learning period that a degree of transfer could be presumed, and (2) a transfer test in which observations of student performance to actual child-care problems in a day care center would be made.

Consumer Marketing

This example deals with the application of gaming to the problem of developing consumer buying competencies, particularly with reference to disadvantaged learners.

Numerous studies have shown that persons with marginal incomes purchase consumer goods less effectively than persons with moderate to high incomes. Consumer marketing specialists attribute the ineffective purchasing behavior to inadequate home economics education. Many individuals of disadvantaged or otherwise deprived backgrounds have never learned how to obtain the maximum dollar value in purchasing food and clothing.

The application of gaming to consumer marketing is a means for providing more realistic situations where students can learn to apply knowledge of nutrition, arithmetic, and language in making decisions concerning the purchase of food and clothing. For example, students in teams of four to seven compete against each other in attempting to make the most "economical" and "healthful" purchases of food and clothing. As the game progresses more realistic situations can be provided by moving the game at various stages into the proximity of community retail establishments, which also provide experience in confronting adults.

The games approach in teaching consumer buying skills is particularly suitable for disadvantaged students in that it: (1) provides a setting with which the learners can identify; (2) creates the conditions which develop a high level of decision making; (3) stimulates high motivation as it offers active involvement in a concrete form; (4) can be readily adapted to the students' level of skill, knowledge, and decision making ability, (5) creates opportunities for healthy, social peers and subsequently adults; (6) controls and minimizes unpleasant interactions with adults which is often problematic for the disadvantaged; (7) serves to establish purpose for developing language and arithmetic skills in knowledge of nutrition and clothing.

Health Education

Health-services education is one of the newer emerging vocational curriculums. Although society has required trained supportive personnel in the past in the health service areas, the evolving team concept in health occupations has resulted in both the recognition of certain new occupational categories and the identification of a new series of supporting practitioners who must receive specific vocational preparation.

Consider the area of nursing services for example. Only recently have categories other than registered nurse emerged. Now hospitals, clinics and nursing homes have a whole array of supportive type positions, such as nurses aides, operating room technicians, physical therapy aides, medical assistants, orderlies, dietary aides, laboratory assistants, etc.; each falling within the area of responsibility of the vocational education program.

Simulation applications in health education might take the following form.

Nurses aide

Bedside care in the hospital is of vital importance in achieving physical and mental comfort of the patient. Even though the doctor prescribes a fitting treatment for a malady, unless the patient is confident and satisfied that he is receiving suitable care during treatment the effectiveness of the prescribed treatment is apt to diminish. The nurses aide who serves as a member of the team in caring for the patient, particularly during interactions around bedside care of maintaining cleanliness and moving patients, can create patient tension and unrest if improper behavior is employed. For example, the verbal and procedural approaches employed by the aide during patient bed bathing, if improperly handled could emotionally upset the patient to the extent that systemic imbalance might result and possibly counteract the benefits of treatment.

Simulated episodes depicting various patient situations calling for bedside care could be developed on 16mm film. Filmed episodes could include such activities as changing bed linen, assisting the patient to turn over or get out of bed, bathing the patient, cleaning up after the patient has spilled a food tray, etc. The instructional emphasis in these types of problems would be on appropriate language behavior in giving the patient directions, asking the patient questions regarding his comfort, and providing a generally cheerful, healthful climate. Feedback footage revealing possible patient reactions as a result of aide verbal and/or procedural behaviors could also be produced. Prospective nurses aides, while confronting the problem episodes, would be instructed to "act out" their responses; after which they would view a feedback episode showing typical patient reaction to those actions. Performance criteria would have to be developed based on opinions of nurses, doctors and behavioral scientists to judge the adequacy of aide responses. Deficient performance could then be readily detected and sufficient practice opportunities provided until suitable behavior was exhibited.

Dental Assistant

Very similar to bedside care of hospital patients, chairside care of dental patients calls for particular competencies on the part of the dental assistant. Again simulation offers an excellent means for providing practice of such skills without jeopardizing the welfare of the patient. Consider the infrequent occurrences of patient emergencies while in the chair. Such events as patient syncope (fainting), epileptic seizure, heart attack, and hyperventilation seldom occur in the dentist chair, yet when they do it is possibly a life or death matter regarding the care given. Of course this does not imply that the dental assistant is solely responsible to care for the patient during such emergencies. Such care is properly the responsibility of the dentist; however, the knowledge possessed by the assistant in helping the dentist care for such emergency occurrences, could well mean the difference of the dentist's success in treating the problem.

Simulated filmed episodes of the above mentioned emergencies portrayed in the setting of the dentist's office could be produced to provide student dental assistants practice in judging symptoms as well as responding with appropriate supporting help to the dentist. Feedback loops could provide rather convincing evidence of improper actions, particularly if the filmed patient were observed expiring. This concept has already been successfully developed for use with dental students at the University of Oregon Dental School (Lund, 1966).

Business Education

The objective of business education is to prepare students to meet the manpower needs of the nation in work related to the facilitating function of the office and include such functions as recording and retrieval of data, supervision and coordination of office activities, internal and external communications and reporting of information. Specific training available includes programs for clerical occupations, secretarial operations, bookkeeping and accounting occupations, real estate, management, and data processing.

Secretary

The job of secretary obviously includes a broad range of skills including taking dictation, typing, operating duplicating machines, using transcription machines, filing, using the telephone, etc. To discuss the application of simulation in this area, an example involving transcription machines will be used. New technology has virtually made obsolete, in many businesses, the routine of dictating a communication to a secretary who diligently records it in shorthand for subsequent typing. Not only does the practice of taking dictation prohibit the secretary from performing other productive activities during dictation, it also constrains the person giving the communication to do so in the proximity of a secretary.

The newer portable dictaphones and casette recorders make it possible for communications to be prepared at any convenient location--in the office, driving a car, at the airport, while flying, at home, etc. At the same time such devices permit many types of communications to be recorded; e.g., simple letters, complex contracts, rough drafts of manuscripts and ideas that are to be expanded upon later. After the communication has been recorded, the tape is given to the secretary who, using a transcription machine to play back the tape, types the material and returns it to the person who prepared it for critique and editing. Although this method of transcribing communications provides many advantages to the message creator, it does place additional demands upon a secretary that are not present in the traditional shorthand approach. For example, the secretary is not able to ask for clarification or the repeat of statements made; the ambient noise level present during taping may, at times, become distracting since the recording might be taking place while driving a car at highway speeds or in a room where other people are speaking or noises are being emitted; the pool secretary must contend with several different message creators whose voice characteristics on tape might vary considerably one from the other, making it difficult for her to clearly interpret and decipher the recordings; and erratic recording speeds due to weak batteries in portable type casette recorders which cause voice pitches to fluctuate and sound strange. All of these conditions require skills in a secretary which were not called for in the traditional face-to-face dictation-shorthand context.

The problems cited above can reduce the advantages of using portable dictaphones and casette recorder units if secretaries are not sufficiently skilled in handling them since the message creator would need to give additional time to clarify to the secretary what he had recorded on the tape. Therefore, the successful use of these newer transcription machines is contingent upon the secretary's competence in skillfully handling the range of problems associated with them.

Through the application of simulation, training systems can be developed which confront secretaries in training with problem episodes possessing a high degree of realism. For example, transcription machine tapes, of various types if desired, can be prepared to contain dictated messages of variable types. Messages can be prepared ranging from very simple letters to highly complex contracts and requiring various formats and chart outlines. These taped preparations can be made using different voices, including dialects representative of various parts of the United States and some of foreign extraction. Other distracting factors can be inserted such as changing degrees of background noises and conference discussions where speakers overlap each other's comments.

A student manual could be developed which contains instructions to the student describing how to use the tapes. Special demands, such as limited time in preparing a typed copy could be included as well as a complete type script of each tape so that the student typist could judge the accuracy of her transcriptions. Obviously, the essential elements of transcription equipment, including a foot feed control, must be available. In addition, a criterion instrument should be prepared which contains additional but different recorded examples equivalent to those used during instruction.

Accounting

Although simulation applications employing filmed modes do not emerge immediately to the writer's mind as particularly desirable forms to use in developing simulated instruction in accounting skills, the use of packaged kits which include printed materials along with an audio tape seems excellent. Such a kit might contain artifacts of an actual account including purchase orders, billing's slips, cancelled checks, the accounting form, etc. The audio tape could contain simulated verbal episodes of principals associated with the account, either represented in the form of phone calls or personal confrontations. A guide booklet would instruct the student in how to proceed in setting up the account as well as to cue the student when to play various portions of the tape.

The use of simple casette recorders and reproduced copies of original account materials would make this simulation application very inexpensive.

The application of a packaged kit similar to that described above has been developed by Krumboltz but for the purpose of career counseling (1967). In his research, Krumboltz developed a problem-solving kit which orients the student to the situation of an accountant who has been consulted by the owner of a small sport shop about diminishing profits. The packet contains canceled checks and a facsimile of the records kept by the bookkeeper of the shop. The student is expected to determine a number of discrepencies in the account involving forged signatures, overpayments, possible kick-backs and misappropriated funds.

Although Krumboltz's kit was designed to stimulate the interest of students in accounting, it could easily form the basis of a learning kit. Each of the discrepencies evident in the sport shop account could form the basis for a simulated learning problem wherein students acquire the necessary sensitivities to skillfully detect and process such accounting problems.

Trade and Industry

The major goal of trade and industrial education is to prepare students with the skills, technical knowledge, safety attitudes, work attitudes and practices required to enter employment at a skilled or semi-skilled trade, craft or occupation which designs, lays out, produces, processes, assembles, tests, maintains, services, or repairs any product or commodity.

This is probably the broadest of all the vocation education areas and includes programs for manufacturing, construction, mechanical service, personal service, public service, and fisheries occupations.

Automotive Repair

Although the general auto mechanic must acquire specific repair skills related to particular components of an automobile if he is to enter this line of work, he also must meet with the customer in initiating and closing business transactions. This calls for particular skills dealing with human relations and communications. It is not uncommon for customers to become annoyed and upset with an automotive repairman either because of undesirable performance on the part of the auto mechanic or because of being disatisfied with the repair of the automobile. These problems seem to center most strongly around poor human relations skills on the part of the mechanic, or his misinterpretation of customer need. Although no known data are available, it is highly likely that a great deal of customer dissatisfaction with auto repair services is directly related to the inability of the auto mechanic in obtaining sufficient data from the customer prior to the initiation of the repair work.

Therefore, the skill with which the automotive repairman adequately interrogates a customer bears directly upon the subsequent success that he can accomplish in satisfactorily servicing a customer's automobile. Here again, simulation can be employed as a powerful technique to develop effective training materials.

For example, 8mm film loops could be utilized to provide numerous problematic episodes which depict various types of customers bringing different automotive problems to the shop for repair. The learner could be directed to respond verbally to the filmed customer and solicit specific information from him. The student's remarks could be recorded on audio tape along with the customer statements and played back for his own private critique. The tape could also be played back in the presence of an instructor if the student wanted teacher evaluation of his efforts or was unable to find his deficiency. Each problem episode would be of limited duration, perhaps two to three minutes in length. The filmed customer should be representative of the average adult who frequently has difficulty in trying to explain what he wants done to his car. Various feedback loops could be prepared which show the customer responding in a variety of ways; for example, being more concerned with how soon the repair can be made to the car rather than to clarify for the repairman the true nature of the problem, asking for cost information before giving a clear definition of the scope of the problem, or casting disparaging remarks regarding the automotive repairman's competition down the street. By developing a comprehensive learner manual, the system could become somewhat self-instructional in nature; that is, the manual could contain the criteria by which a student could judge his responses and to determine which feedback loop to use or to continue with a subsequent problem unit. Sufficient auxiliary information should be provided to set a somewhat realistic situation in which the learner then confronts the filmed episodes.

An alternate and perhaps supportive application of simulation using video tapes could be employed to teach customer interrogation skills. Role playing episodes could be established with one learner assuming the role of automotive mechanic and the other that of the customer. The customer role would have previously prepared cues for him to follow in confronting the repairman. The student acting as the automotive repairman would then attempt to interrogate the customer in an effort to determine the problems of his automobile. Reality constraints could be periodically introduced to take the form of such things as telephone interruptions, the entrance of another customer who is in a hurry to take his car that has already been repaired, the return of an irate customer who is disatisfied with the performance of his recently repaired car, etc. By video-taping the role playing interactions the student would have immediate access to replays of his own performance in the role playing situation. Video recordings are particularly powerful with respect to allowing the learner to see himself as he actually performed rather than as he perceived his performance in his mind. This technique has had considerable success in the form of teacher confrontation in recent research conducted by the Teaching Research Division (Jensen, 1968).

The video tape system could work in conjunction with the film loop materials either as a prelude or a follow-on situation. It is quite conceivable that the learner would confront problematic situations in the video-tape setting which he is unprepared to answer and would wish to confront filmed episodes which could provide him practice in the deficient behaviors. The reverse procedure might also apply. After certain learning sequences from the film loops the student might wish to engage in role-playing confrontations to test his ability in more of a free give-and-take situation.

Sheet Metal Fabrication

In the growing use of sheet metal in manufacturing and the construction of homes, businesses, and industrial plants, sheet metal fabricators must be prepared with competencies in areas such as drafting, pattern development, locks, seams, fastenings, and bend allowance. Sheet metal fabricators must develop unique perceptional skills for visualizing, from a set of specifications or flat drawings, the end product with all of its subtle bends, curves and angles. In addition, they must anticipate the stretch or shrink effects of bending various guage metals and take into account the warping influences caused from heat produced in welding the parts. Regardless of how skilled the fabricator might become in cutting, shaping and bending, unless his basic perceptual capabilities are sufficiently advanced such that he can visualize from a layout on flat metal sheets how it will shape into the final product, his effectiveness in metal fabrication is limited.

The use of 35mm slides appears to offer a good media to simulate sheet metal fabrication problems for the development of perceptual skills. For example, various sheet metal objects including and combining representative classes of angles, curves, corners, and seams, commonly encountered in sheet metal fabrication, would need to be identified. The objects could be photographed in various stages of completion showing details of different surfaces and viewed from several angles. A student workbook could also be developed to coordinate use of the visuals and to provide specifications for specific fabrication examples.

Problem sequences starting from the more simple problems and becoming increasingly more complex could then be developed. Problem situations could be developed around a reverse order of completion. That is, the initial problem would confront the student with a fabrication object, presented in next-to-finish condition for which the student would be required to visualize what steps would be necessary in completing the particular object. The next problem would back up the fabrication sequence and confront the learner with two steps removed from the finished object. This procedure would continue until the learner had confronted the total task from layout to completion. Feedback sequences showing correct responses would be essential at each learning step. The more common types of mistakes in fabrication could also be photographed and coded in such a way as to permit the student opportunity to examine the effects of incorrect perceptual strategies. With the improved slide projection equipment now available, both forward and reverse sequencing of slides could be used by the learner. For example, some particular knotty perceptual problem might not become clear to certain learners merely by exploding the sequence from start of fabrication to finished object; however, if the sequence could then be reversed, moving from finished object to initial layout, the logic of making certain critical angles or bends might become evident.

It would seem that by combining the above suggested slide-workbook problem sequences with situations that challenge the learner to produce models of the studied objects using very thin, soft metal sheets, maximum outcomes could be achieved. In model building situations the learner could be provided actual "hands-on" learning opportunities of perceptual skills.

Distributive Education

Distributive education equips students with the necessary competencies required in the field of distribution and marketing. It is designed to prepare individuals to enter or improve competencies in business operation, product and service information and salesmanship. Emphasis is upon the development of skills, attitudes, and understandings related to marketing, merchandizing and management. Distributive occupations are found in such businesses as retail and wholesale trades, insurance and real estate, financing, manufacturing, services and service trades, transportation, utilities, and communications.

The field of distributive education has become vital in recent years to prepare manpower who can contend with the vastly improved capabilities that automation has given production. More people are needed today in the distribution and marketing of products and services than ever before in history.

Salesman

Although salesman jobs vary greatly in terms of the products or services involved, they all have similar requirements in terms of communications, human relations, public relations, sales promotion, etc. Each of these areas calls for a unique set of skills that without, the salesman cannot succeed.

In the past the preparation of salesmen has been largely handled either on-the-job or by the training arm of the employing firm. Because of the growing demands for manpower in the distribution and marketing area, the schools must increasingly assume a significant role in the training. In this regard, the application of simulation appears particularly useful for developing excellent learning opportunities.

The use of 16mm films and video tapes in combination could be particularly helpful in teaching future salesmen basic skills of speaking, including phonation, articulation, pronunciation, and the art of listening, and giving talks. While the learner confronts filmed characterizations of typical customer behaviors, his performance could be recorded on video tape. Immediate replay of the tape in juxtaposition with the filmed episode just confronted would provide the learner innumerable opportunities to study his pattern of interpersonal behavior including how well he listened and attended to non-verbal signals transmitted by the filmed customer. Further careful analysis of the video tape would provide the learner evidence of his speech deficiencies.

Merchandising

Success in the field of merchandising, besides other things, requires that the incumbent be sensitive to basic textile fibers, fabric construction, fabric finishes and fabric identification as they influence the consumer in such things as wearing apparel and accessories, home finishings, hardware, etc. A simple application of simulation here could call for the use of 35mm slides with descriptive audio tapes and student workbooks for teaching basic textile information. Although it would be desirable to have artifacts of real textiles available for the learner, the cost of procurement, keeping them updated, and the logistics in storage and display make this rather unreal. Slides of the basic textiles and of fabric variations, on the other hand, would not present such problems. In addition, audio tapes could easily and cheaply be prepared and updated as required. The use of multiple projectors at select time periods would permit excellent opportunities for learners to identify similarities and differences within and between various classes of textiles.

Technical Education

Technical education programs are designed to prepare individuals for employment in a wide cluster of occupations in the sphere of technology. The work of a technician requires the knowledge of the underlying sciences and supporting mathematics belonging to a technology, and of the processes and materials commonly used and the services performed in the technology. The technician frequently works in support of another person, who is usually classed as a professional, and contributes to such functions as designing, developing, testing, adapting, planning and reporting.

Draftsman

The draftsman's job is to detail specifications for a product that have been given to him in visual form in such a manner as to make clear to the rest of the team concerned with its production and distribution exactly what is to be produced, assembled or modified. He must be fluent with the symbols and signs required by the industry to transmit meanings, since many individuals will use the drawings.

In large scale firms, e.g., hydraulic pump manufacturing, working drawings typically are routed as follows: First they are passed on to the production section where they may take one or several routes depending upon the nature of the product: to the pattern shop for conversion into actual size patterns, to the forgery for translation into metal shapes, to the plate shop for interpretation of cutting metal parts, etc. If patterns are made, they go to the foundry where they become converted into rough cast parts. The drawings are essential to provide foundry workers true prospective of the total finished product. Next, all metal parts are machined to finish requirements, again calling for careful reference to drawing specifications. Inspection of all parts then occurs checking against drawing specifications. The assembling of all parts into the finished pump follows, once more calling for guidance from the working drawings. The final stage concerns the distribution and installation of the pump and must also be accompanied by the working drawings to provide essential data. Thus, the drawings are a vital communication linkage following the pump from its initial creation to its eventual operation.

All too often the newly hired draftsman is insensitive to what actually happens to his drawings and who will make use of them. Certain production difficulties frequently take place because of his naivete. For example, in detailing a set of drawings for a product, certain noncritical elements (from an engineering point of view) are left to the discretion of the draftsman. Such things as where to position certain connectors between parts, how to shape portions of the body, at what angle to place lubrication fittings, etc., must be determined by the draftsman. Unwise decisions of some of these details make production's job considerably more difficult. For example, such a simple thing as placing a connecting pipe between two parts of a pump, if poorly positioned by the draftsman, might prevent access to other critical fittings, thereby causing problems to the assembling of the pump. By positioning the pipe in another place the problem of assembling could be avoided. Therefore, to increase his effectiveness in producing drawings that meet production's needs, the draftsman should be well aware of who will use his drawings and for what express purposes. Simulation offers an excellent means for sharpening the sensitivity.

Consider the problem just described. The student draftsman can be confronted with facsimile drawings, representative of various classes of products, which call for decision making regarding the completion of certain unfinished details. The situation could be considered a problem solving one in which successful completion of the drawing is dependent upon the appropriate placement of details in the drawing.

Simulation materials could consist of (1) a kit containing a particular unfinished drawing, engineer specifications for the drawing, and resource materials perhaps including two or three older drawings from which the newer one was being adapted; (2) a talking film strip or a set of slides with tape designed to give the student information regarding where finished drawings are routed in the firm and how each place uses them; and (3) sets of feedback slides and tapes (or talking film strips) developed to show and explain as a result of one of three or four alternative ways to complete the drawing, what problems, if any, were caused to production and sales by that alternative.

A guide booklet instructs the student when he has completed his drawing and which feedback sequence to select. Based on the information he acquires from the feedback sequence he is instructed to either try completing the drawing again, or that he has reached a satisfactory solution and to select another problem.

Production Technology

The field of production technology, although somewhat new in title, has been a part of the larger concerns of production management for some time. Production technology is concerned with quality control, production planning, and strength of materials in manufacturing. As in other occupations, cost/effective concerns of manufacturing are calling for workers who are specialists in giving attention to ways of improving production effectiveness.

In a general sense, simulation of various facets of manufacturing could provide excellent instructional opportunities. Simulation could be applied ranging from the sophisticated applications of computers where a manufacturing firm's total production data is simulated and printed out, to the simple use of gaming in competition of production planning.

Through the application of a computer system, a fictitious (or real) firm could be created. Students could then be confronted with a data profile showing the recent trends of the firm and asked to plan for the immediate future in terms of market estimates, influences of minority groups on product buying, implications for in-plant training, etc. Obviously, such a system would be hardware expensive and hardly justified unless sufficient numbers of learners would be involved.

On the other hand, the gaming of production planning would be virtually cost free, requiring only a few stencils and sheets of paper. The game could be designed such that two or more teams of students would compete in developing the best judged production plans. Additional game members would be required to perform in the roles of resource persons, evaluators, and reality forces. Game rules would have to be established that took into account, as far as possible, actual operational data available from a particular manufacturing establishment. Alternate games could be developed representative of various classes of manufacturing firms.

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V. Situational Response Testing: An Application of Simulation Principles to Measurement

H. Del Schalock

The thesis of this paper is that the concept of simulation has as much to contribute in the area of measurement as it does in the area of instruction. The aim of the paper is to present the rationale underlying this thesis and to illustrate the promise that the methodology holds in measurement by reviewing several programs in which the methodology has been applied. Finally, some of the critical issues facing the application of simulation principles to measurement are identified and research directions suggested.

The Rationale Underlying the Application of Simulation Principles to Measurement

Perhaps the soundest of all psychological principles is that which is represented by the formula $B = f(PE)$. Behavior is always a function of an interaction between that which an individual brings to a situation (P) and the situation itself (E). The behavior of a mother toward a child is always a matter of the characteristics of the child with whom she is interacting, the characteristics of the setting within which interaction occurs, the objective that is expected to derive from the interaction, etc. The same is true for a teacher: the behavior of a teacher is always a function of the objective being pursued, the characteristics of learners that influence both what they will learn and how they will learn it, the characteristics of the setting in which the instruction is to occur, and the instructional materials and activities upon which a teacher may draw to facilitate the outcomes desired. This has also been found to be true with such characteristics as aggression (Bandura and Walters, 1963), and leadership behavior (Bass, 1960). One of the most remarkable phenomena in the educational and psychological literature on measurement is the fact that both measurement theory and practice have failed to reflect an appropriate sensitivity to this most basic of behavioral science principles.

Generally speaking measurement practice and theory have been most insensitive to the contextual side of the equation. This is the case in both efforts to measure the existence of educational and psychological constructs and in efforts to predict behavior. When constructs being measured are of a kind that permit words or other abstract symbols to function appropriately as test stimuli, for example, abstract problem solving skills (intelligence), mastery of knowledge (school achievement), attitudes, and interests, traditional approaches to educational and psychological testing have been relatively successful. When other kinds of constructs are being measured, however, for example, the constructs of self-concept, social sensitivity and trust, traditional approaches to testing have not proved very successful. One reason for this may be that their successful measurement requires test stimuli other than words or abstract symbols. Put in another way, it may be that the measurement of constructs that take their definition in contexts that are other than abstract or symbolic require that those contexts be portrayed in terms other than words or symbolic abstractions. Simulation methodology provides the means for such portrayals.

Dependence upon an adequate portrayal of context is even more critical in measures designed to predict behavior. By-and-large efforts at predicting behavior by educators and psychologists have been even less successful than efforts to assess personality constructs that are dependent upon other than abstract, symbolic contexts. Generally speaking it is rare to find in education or psychology a predictive scheme that has sufficient power to account for more than half of the variance in a criterion involving complex human behavior. At best fifty per cent of the variance in academic achievement in college, job success and occupational choice and satisfaction is able to be predicted (Cronbach, 1960; Ghiselli, 1955). Prediction to performance in public school teaching (Mitzel, 1960), clinical psychology (Kelly and Fiske, 1951), success in professional educational programs (McGuire, 1968) or various Air Force activities (MacKinnon, 1958) is even less successful, and prediction to specific patterns of inter-personal interaction, such as interaction between husbands and wives, parents and children or teachers and children has not even been attempted. As yet the major part of human behavior and performance cannot be predicted with the accuracy hoped for within the behavioral sciences, but here again simulation methodology offers promise as a means of improving this circumstance.

Simulation as a Methodology for Increasing The Range of Educational and Psychological Constructs that can be Measured Effectively

Traditionally, educational and psychological tests have relied upon the use of words or other symbols to provide stimuli to which testees respond. When attempting to measure relatively simple symbolic manipulations, such as knowledge of facts or statements of attitudinal position, words or similar symbols appear to be appropriate as test stimuli. When attempting to assess constructs which are defined in terms of their relationship to more complex phenomena, however, such as the sensitivity of a person to the behavior or feelings of another, or the orientation of a person towards dominance or supportive relationship with another, words or other abstract symbols probably do not suffice as test stimuli. When one is concerned in measurement with the relationship of human characteristics to dynamic and complex interpersonal settings the multiplicity and subtlety of cues which are acted upon to shape such a relationship, especially those that shape the affective or emotional dimensions of it, demand that media other than or in addition to words be used to convey the essential characteristics of such settings. The assumption underlying such a position is, simply, that if responses to complex situations are to be measured effectively there must be a reasonable representation of the setting to be responded to, and that words cannot effectively represent the essential characteristics of such settings. What is more, if we were to take seriously the existing evidence from perceptual and semantic studies, even if it were possible to describe in words such situations error stemming from misunderstanding and individual interpretation of terms would, for all practical purposes, eliminate objectivity.

If this analysis is correct it follows that educational and psychological tests that attempt to assess constructs that depend for their definition upon dynamic, complex interpersonal settings must depend upon media that are more complex than words or other abstract symbols to present test stimuli which accurately depict such settings. Granting such a position it requires that one look beyond traditional paper and pencil methods of testing and explore the whole array of stimulus presentation modes made available by the methodology of simulation.

In addition to the issue of stimulus complexity in the measurement of complex educational and psychological constructs there is also the question of response complexity. With the exception of projective instruments, educational and psychological tests typically employ "fixed response modes," that is, the respondent is either to choose one of several alternative responses that have been provided for him or he is to provide a well defined response which subsequently can be judged right or wrong against some pre-established criterion. While the relationship between response complexity and test effectiveness has only begun to be investigated (Schalock, Beaird & Simmons, 1964) (Schalock & Beaird, 1968) it is logical to assume that response freedom provided in a test is as closely related to the power or effectiveness of the test as is the stimulus properties that it contains. In fact, the rationale for such a position follows closely that supporting the significance of stimulus complexity: the greater the stimulus complexity of a test the greater the need for the opportunity to response with complexity, or at least the need to respond idiosyncratically. In carrying the parallel further it would seem that as stimuli offer more cues to meaning they also invite more variety of response, and as the variety of response possibilities increases there is a corresponding need to be able to respond with variation. If this should be the case the capacity of traditional response modes to tap the range of response alternatives in a complex test probably is limited, and therefore, to be maximally effective, tests involving stimuli of "life like" complextiy might well have to involve a response mode permitting the freedom of "life like" response. Within this framework, stimulus and response complexity go hand in hand, and the testing of hypotheses about one requires consideration of the other.

The point of view outlined in the paragraphs above has particular relevance for the assessment of educational objectives. If an educator or educational researcher is to undertake the measurement of classes of educational objectives that heretofore have been largely unmeasured then he is going to have to rely upon more than paper and pencil measures. This rests upon the assumption that the aim of any educational achievement measure is to obtain a sample of the criterion behavior, i.e., the behavior which is specified in the behavioral objective, or a sample of behavior or the products of behavior which presumably relate to the criterion behavior. How else can one obtain evidence that an educational objective has in fact been realized? Given such a point of view, paper and pencil tests are not at all appropriate to the measurement of the full range of objectives which most educators hold as appropriate. When the focus of measurement is upon "knowledge," e.g., concepts, facts, and principles, or when it is upon the application of knowledge to a set of tasks that require only the manipulation of symbols, e.g., the solution of a mathematics problem, outlining the steps involved in building a house, or writing a theme on the expression of consideration in one's relations with others, paper and pencil measures are perfectly appropriate. When the focus of measurement is upon building a house, however, or upon relating considerately to others, a paper and pencil measure won't do--unless one is willing to make the assumption that being able to outline how to build a house or how to behave considerately is in fact related to the ability to build a house or to act considerately. While most people would probably accept the idea that the knowledge factor is related to the concrete performance factor, few would accept the idea that the relationship is perfect. If this is true, then measures other than or in addition to those which require only the manipulation of symbols are needed in order to assess some of the more critical objectives of education.

The extent to which a measure draws upon the performance of the concrete behavior that is the target of the measure has been referred to by Schalock (1969) as the fidelity of a measure: does it require behavior that is isomorphic to the objective of measurement (identical to it) or does it call for behavior that is only in some way related to it. Ideally, all measures of educational or other performance objectives should be isomorphic, but since the realities of educational or other settings sometimes make this impractical the general rule to be followed is to make one's measures as high in fidelity as is practically possible.

Many years ago Lindquist (1950) proposed four alternative approaches to the measurement of educational objectives: (1) give the examinee occasion to do some of the things that are specified by the objective (an isomorphic, situational response test); (2) give the examinee occasion to do things similar to some of those specified by the objective, (a "related behavior" situational response test); (3) describe a situation in which the examinee would have occasion to do what the objective specifies, and then ask him to tell what he would do in this situation or how he would do it (a "verbalized behavior" situational response test); and (4) discover whether or not the examinee knows the facts, rules, principles, etc., that are presumably essential or conducive to the desired behavior, (a "knowledge" test). At the time Lindquist wrote his paper educators were measuring essentially at the knowledge level, and his plea was to get them to move to a higher level of fidelity. Today they are still measuring essentially at the knowledge level, and the plea is still relevant.

This is not meant to imply that measurement should avoid focusing at the knowledge level; indeed, many educational objectives are focused entirely at that level. Also, there is obvious truth in the argument that knowledge is essential or conducive to the overt behavior with which an ultimate educational objective is concerned, i.e., there is a relationship between what and how much an individual knows, and how he will behave in certain situations. The point of the discussion here, however, is that while the measurement of knowledge is in many instances a worthwhile educational goal it is not education's only goal, and that when educational objectives other than knowledge are being measured a methodology of measurement other than that appropriate to the measurement of knowledge must be employed.

To date the concept of the fidelity of a measure has not appeared in the literature on test theory, so the concept has little empirical testing and carries no analogues. On the surface, however, it appears to be a useful concept and the methodology of simulation provides the means whereby it can be made operational.

Simulation as a Methodology for Increasing The Predictive Power of Educational And Psychological Measures

Traditionally test theory has reflected the point of view that failure in the prediction of complex human behavior has been a function of the interaction of a number of factors, for example, the complexity of human behavior, the limitations placed upon investigators in the manipulation and control of subjects, and the failure tests used in the prediction scheme to reflect all of the variables affecting that which is to be predicted. As a consequence, the strategy of prediction generally has been to narrow the range of phenomena to be predicted, tighten research design as much as possible and increase the number of tests used in the prediction battery. While this seems a perfectly sensible strategy, given the frame of reference from which it derives, it has not as yet proved effective. Behavior to be predicted has been carefully defined, research design has been increased in its sophistication and multivariate tests or large scale test batteries have been used, but predictive effectiveness has not been increased greatly.[1] Given the traditional rationale regarding prediction the upper limit of predictive effectiveness with respect to complex human behavior seems to have been reached. If predictive effectiveness in this domain is to increase it is now apparent that it will do so only through the evolution of predictive instruments that are more powerful than those which are currently available (McGuire, 1968).

If this analysis is correct it follows, as in the assessment of complex educational and psychological constructs, that the predictive effectiveness of tests rest in large part upon the ability to present test stimuli which correspond in complexity to the stimuli which ordinarily elicit the behavior that is to be predicted, and upon the opportunity to respond to those stimuli with the freedom that is ordinarily available in life settings. The rationale for such an approach rests upon the assumption that as test stimuli become more complex, and as test responses are free to parallel that complexity, tests resemble more closely the life situation to which one is predicting and they therefore should be more effective as predictors.

This emphasis upon the representational qualities of predictive instruments will be recognized as consistent with the rationale underlying the use of "job replication" tests as a basis for prediction. Cronbach (1960 has commented:

> "In trying out tests with the hope of finding a good predictor, past experience with the job replica seems to offer the best bet. The common sense rule that the test which resembles the job ought to predict the job has generally paid off with encouraging validity coefficients. If intelligently designed, the job replica can demand the same coordinations, speed and precision as are called for in the criterion task. Furthermore, it looks like a reasonable test, and therefore appeals to the subject and to the employer on whose behalf the tests are used. There is little doubt that job replicas will continue to be used in industrial and military selection for some time."

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[1] Though approached from a different point of view, McNemar (1964) comes to a similar conclusion with respect to intelligence testing.

In their pure form job replication procedures would be difficult to apply to tests attempting to predict behavior in all settings in which educators and psychologists are interested, for such settings are essentially without end. Some degree of standardization or control could be brought to the depiction of settings, however, through the application of simulation methodology. By employing slide/tape presentations, motion picture films, or some other form of "micro-representation," settings could be depicted at various levels of fidelity, all of which would involve to one degree or another the critical or essential elements of the real setting being depicted and all of which would involve a constant set of stimuli to which testees could respond. While not as rich or powerful in stimulus properties as real life confrontations, these various levels of simulations can provide a much greater range of stimulus complexity and subtlety than can traditional test strategies.

A major assumption underlying the use of simulated or situational response tests is that they should offer a partial solution to the problem of knowing whether test performance reflects how the respondent will actually behave in a life situation or merely how he thinks he should behave. The issue of overt versus verbal behavior is a crucial one for there is increasing recognition that knowing what to do in no way guarantees that one will act accordingly. By using relatively high fidelity simulation as test stimuli it is anticipated that a respondent would project himself into a test situation more than he would if the situation were described on paper and, as a consequence, would be less subject to verbal mediators, more emotionally involved, and thereby more likely to respond in a way comparable to the way he would in a real life situation. If such were the case, predictive effectiveness would be increased appreciably.

Examples of High Fidelity Simulations Applied To Educational and Psychological Measurement

A number of applications of high fidelity simulations, i.e., test stimulus and response modes which elicit life like behavior, have appeared in educational and psychological testing programs. Tests of this kind range from those requiring elaborate equipment, such as a flight simulator, to nothing more than elaborate paper and pencil measures (Weislogel and Schwartz, 1955), but all have the common characteristic of the examinee behaving in the test situation as though he were in a real life situation. This is in contrast to having the examinee say what he would do or display characteristics which are in some way logically related to the behavior expected in the depicted situation.

The In-Basket Test

The use of an "in-basket" methodology in the assessment of life like behavior involves response to a series of items that call for decisions as they would be responded to in real life job performance. This technique has been used widely in business management training (Jaffee, 1968) and in school administrator training (Hemphill, et al, 1961). In the Hemphill study the in=basket test consisted of facsimiles of the letters, memoranda, and other contents of the "in-basket" that is found on most school principals' desks. The test requires each examinee to respond to the in-basket items and to perform such other tasks as participating in committee work, preparing probationary teacher report forms, preparing for interviews with probationary teachers on the basis of teacher observations (by means of kinescopes), and reacting to conference situations presented by means of tape recordings. Each participant leaves a record of the behavior which he carries out in response to each of the problems presented, i.e., memos, letters, notes to himself, reminders to make phone calls, instructions to the secretary, recommendations, etc. which can then be scored by independent judges or raters.

The test situation begins by having each participant learn of the school in which he is to be the new principal (a fictionalized school in a fictionalized city). He is instructed to bring to his new job his own background of experience and his own knowledge and personality rather than to pretend he is someone else. The participants spend the first day and a half in learning about the hypothetical school and community in which it is located through film strips, survey materials, personnel folders, floor plan of the school, staff roster, etc. At the end of a day and a half of orientation the subjects have as much information about the school as would be expected of a new principal in an actual situation, and as a consequence they are in a position to be able to take action on problems arising in the administration of the school in a way comparable to any new administrator coming in.

By-and-large participants in in-basket assessment programs have reported that they are extremely realistic, but there is as yet little evidence as to the predictive validity of such measures (Gray and Graham, 1968). Participants typically report that their responses to the "simulated" situation are much like their responses to similar life situations, and that they even build up images of the people involved that are sufficiently realistic that they form likes and dislikes much as they would in a real setting. The advantage of a simulated school or business over a real school or business is, of course, that the situation is highly standardized and that it is manageable from an economic point of view.

The Russell Sage Social Relations Test

Several years ago the Russell Sage Foundation supported a study of elementary school objectives (Kearney, 1953). A primary purpose of the study was to focus attention on the measurement needs in the area of evaluation of elementary education. The report of the investigators specified many objectives other than the conventional academic ones, including some social skills such as skill in cooperative group planning and action.

The Russell Sage Social Relations Test, developed by Dora Damrin (1959), was a direct outcome of the project. It represents an attempt to build a test which can be used to evaluate schools with respect to their success in teaching "social relations." More specifically, the test is intended to measure the performance of a class with respect to (a) skill in cooperative group planning procedures, and (b) skill in techniques of cooperative group action. The test is of the type which provides standardized occasions for eliciting behavior relevant to such educational objectives.

The approach is straightforward. To measure skill in group planning and acting, the class is given problems which require them to plan and act in a cooperative way. For each problem, 36 interlocking construction blocks of various colors and shapes are distributed to the children. They are also given a model made of similar blocks which they are to reproduce exactly with their 36 blocks. The three problems involve models of a house, a footbridge, and a dog. The first part of the test has to do with the planning phase. The examiner tells the children what their task is and that they may help each other, discuss things freely, and work cooperatively. They may have all the time they wish for planning, but they are allowed only 15 minutes for constructing the model. When the plan is completed and all the children have it in mind, the construction job is carried out and is timed by the examiner. The second and third models, which are more difficult, are built in a similar way.

During the time the children are in the process of planning, an observer keeps a record of their behavior, using standardized observation sheets. The data so collected are later translated into numerical scores which reflect the skill of the group in various aspects of cooperative group planning. A similar set of observations is made for the action phase of each problem. Scoring has to do with such characteristics as amount of participation, communication, autonomy of the group, organizational techniques, quality of the final plan, and time required to complete the model. All scores are given in terms of group performance.

As yet there is no evidence as to the reliability or validity of the instrument, beyond its obvious face validity, and as a consequence the usefulness of the measure is unknown. It is illustrative of the concept of situational response tests, however, and for that reason has been reviewed here.

Patient Management Simulation in Medical Education

In 1964 the American Board of Orthopedic Surgery established a joint study of the development of competence in orthopedics for the purpose of improving the certification procedures in orthopedic surgery. The study required that the Board develop a definition of competence in orthopedics and then develop evaluation instruments of proven validity and reliability to assess those competencies. Out of this effort has come a series of branched problems in patient management that require sequential analysis and decision making that reflect aspects of behavior defined as essential components to orthopedic clinical competence. These problems employ simulation techniques similar to those used in management games in military exercises, and are suitable for either individual or group administration and are amenable to either clerical or computer scoring and analysis (Crawford and Lewy, 1965). The rationale for the design of the simulated clinical problems is provided by McGuire and Babbott (1967):

> "A clinical problem which purports to simulate the physician-patient encounter must have the following characteristics: First, it must be initiated by information of the type a patient gives a physician, not by a predigested summary of the salient features of the case, and if it is to be realistic it must be couched in terms the patient or a referring physician would use. Second, the exercise must require a series of sequential, interdependent decisions representing the various stages in the diagnostic work-up and management of the patient. Third, the examinee must be able to obtain in realistic form information about the results of each decision, as a basis for subsequent action. Fourth, once these data are obtained it must be impossible for the examinee to retract a decision that is revealed to be ineffectual or harmful. Fifth, the problem must be constructed so as to allow both for different medical approaches and for variation in patient responses appropriate to these several approaches. Hence, provision must be made for modifications in the problem as the patient responds to the specific interventions chosen by each examinee. Finally these modifications must differ among examinees, according to the unique configuration of prior decisions each has made." (p. 1)

It is this last characteristic which McGuire and Babbott regard as of greatest general significance, and which most clearly differentiates the work of the Illinois group from the work of Glaser and his associates (Glaser, Damrin and Gardner, 1960), the Diagnostic Skills Test of Rimoldi (1963) and National Medical Board Examination for Interns (Hubbard, 1964). In these other tests each examinee is confronted with the same problem, which remains identical throughout for all respondents; thus a premium is necessarily placed on efficiency in reaching a single, correct solution or on the appropriateness of each decision considered independently. In contrast, the branched problems of the Illinois group require the subject to make choices from an almost unlimited number of broad strategic routes, several of which may lead to an acceptable result.

In the orthopedic tests each problem is initiated by a brief verbal description of the patient's chief complaint or by a short color film in which the patient describes his current illness, and the examinee must decide how he will approach his patient, i.e., what work-up seems indicated. An example of the kind of problems encountered and the nature of the testing procedure upon encounter is illustrated by the following.

> Thirty minutes after a light luncheon, a 50-year old woman executive develops severe abdominal pain during a board of directors meeting. The chairman of the board calls you and asks that you see her as soon as possible. At your request he agrees to arrange for her immediate transfer to a nearby hospital.
>
> When you arrive there thirty minutes later, you find the patient lying on a cart in the Emergency Room. She appears to be in severe pain and begs you for relief.
>
> You would NOW (choose ONLY ONE):
> Obtain further history
> Perform a physical examination
> Hospitalize patient for further evaluation and therapy
> Hospitalize patient for immediate surgery
> Hospitalize patient for urgent surgery after preoperative preparation
> Hospitalize patient for conservative management without further evaluation

The examinee records his decision by erasing an opague overlay on a specially constructed answer sheet. This reveals an instruction directing him to the section of the test booklet appropriate to his choice. Suppose, for example, an examinee chose the item: "Hospitalize patient for further evaluation and therapy." His erasure would yield, "Turn to Section X." In Section X he is confronted with the following list of possible interventions, and he is to select AS MANY AS indicated.

Hemoglobin determination
Blood urea nitrogen determination
CO_2 combining power determination
Microscopic analysis of urine
Chest X-ray
Electrocardiogram
Blood smear

When these data are returned he then must decide upon the next step he wishes to take.

McGuire and Babbott further elaborate the procedure and rationale underlying the method:

> "Each problem contains many such sections, some of which are not necessarily relevant to the optimal management of the patient. All sections are arranged in scrambled order, and may be sealed to minimize the possibility of using the options offered in them as clues to the expected behavior. In each new section the examinee must indicate his decisions about a series of specific actions, and at each stage he must make a strategic decision about the overall management of the patient; this decision determines the section to which he is next directed. In this fashion a problem may be carried through many stages, at each of which the examinee must make further decisions based on the specific responses of the patient evoked by his own earlier decisions.
>
> The stages in the work-up and the responses to the specific procedures the examinee may elect are meticulously designed to simulate an actual clinical situation. Results of diagnostic and therapeutic maneuvers are reported in a form resembling that which the physician is accustomed to encounter: in response to an order for a specific test, a laboratory report is revealed; in response to an order for an X-ray, electroencephalogram, electrocardiogram, etc., the examinee is referred to a high quality photographic reproduction of the X-ray or tracing; if he orders a blood smear he is referred to a color plate of the smear; if he wishes to obtain auscultatory data he can be referred to a high fidelity tape recording reproduced through individual stethephones; if he orders medication, the patient's response is reported. No interpretation of these data is offered and none is explicitly demanded of the student; he is merely given the data he requests and is required to act

> on them as does the physician in the conventional clinical setting. However, he may, by making the appropriate erasure, request a consultation for assistance in interpreting the results of any specialized laboratory procedure.
>
> The complications which must be managed differ from student to student depending (as they do in the office or clinic) on the unique combination of specific procedures each has elected at earlier stages. For some the erasures will reveal an instruction to skip entirely one or more sections of a problem because the approach they have chosen is effective in avoiding potential complications with which others must cope. If, however, at any stage the examinee orders something harmful or fails to take measures essential to the recovery of the patient, or he uncovers a description of the clinical features of the complication that has developed, he is then directed to a special section where he has the opportunity to take heroic measures to rectify his previous errors; if these remedial measures are inadequate he may be instructed that the problem is terminated because the patient has suffered a relapse and has been sent to another hospital, or has been referred to a consultant, or has died." (pp. 3 & 4).

Extensive studies on the reliability and validity of the various measures that have been developed for use by the group at the Center for the Study of Medical Education are now underway (McGuire and Babbott, 1967) (Levine and Noak, 1968) and the results to date seem extraordinarily promising. In addition the technique has broad applicability since each problem samples an extended behavioral sequence and is constructed and scored so as to reward a variety of components of competence and efficiency. It also permits alternative valid routes toward a solution and thus provides evidence about problem solving style as well as level of competence. Most critical perhaps is the fact that the procedure yields significant modifications in the nature of the problem confronting each examinee as a consequence of his own unique configuration of decisions relative to intervention--a critical characteristic of most types of real life problems.

The Use of Motion Picture Tests to Predict The Classroom Behavior of Teachers

Recently completed research by Schalock, Beaird and Simmons (1964), replicated by Schalock and Beaird (1968), on the predictive power of tests which use motion pictures as test stimuli provides a final example of the potential application of simulation methodology in measurement. Using student teachers as subjects, Schalock, et al. were able to demonstrate multiple correlations of .69 to .87 between scores on a battery of situational response tests administered prior to student teaching. The general hypothesis underlying the study was that in order to predict to complex human behavior the tests to be used as predictors had to reflect in their composition the complexity of the behavior to be predicted. Specifically, the hypothesis tested in the study was that as test stimuli increased in their representativeness of the behavior to be predicted, and as the opportunity for response to those stimuli approached "life-likeness" in their freedom, the predictive power of tests would increase accordingly. Motion picture sequences of classroom behavior were used in an effort to provide a stimulus situation comparable in complexity to that involved in real life teaching.

The Predictor Measures. Four predictor tests, varying on a continuum of stimulus and response complexity, were used in the study: 1) a traditional paper-and-pencil attitude scale, where the test stimulus was a statement describing an orientation to the teaching function and response was defined by agreement or disagreement to the statement (The Minnesota Teacher Attitude Inventory), 2) a situational-response test where the test stimuli were written descriptions of filmed classroom situations and response was defined by agreement or disagreement to statements made in relation to the situational descriptions (The Word Test), 3) a situational-response test where the test stimuli were motion picture sequences of classroom situations and response was defined as in (2) above (The Film Test), and 4) a situational-response test where the test stimuli were also motion picture sequences of classroom situations but the response was free, i.e., the subject responded to the filmed situation as if he were the teacher in the situation (The Simulation Test). It was hypothesized that the predictive power of the tests would vary in the order of their listing above, with the MTAI being the weakest predictor and the simulation test the most powerful. The relationship of these tests to one another on a continuum of stimulus and response complexity appears as Figure 1.

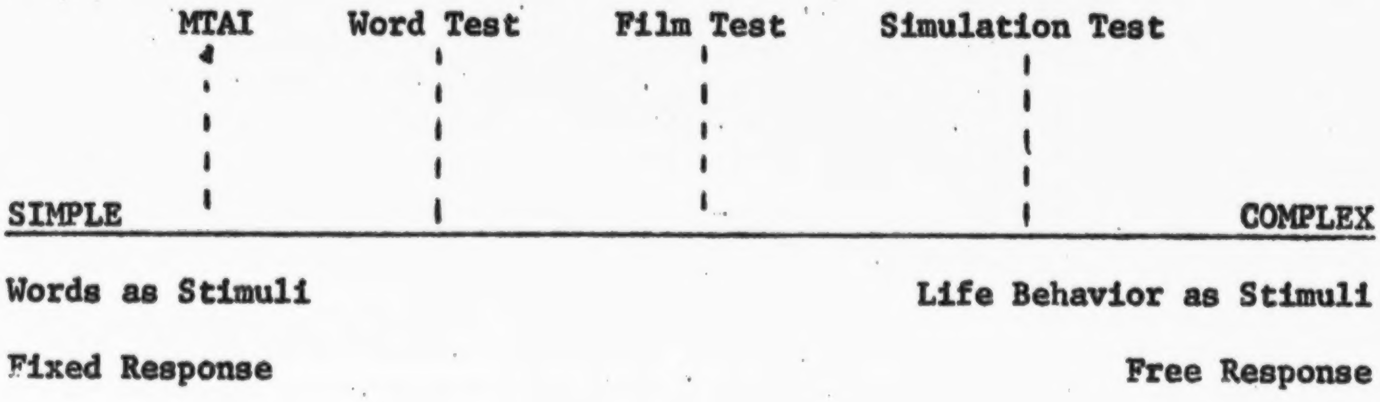

Figure 1. Continuum of test stimulus and response complexity.

The Word, Film, and Simulation Tests were constructed especially for the project. Generally speaking, they were designed to assess a teacher's orientation to classroom management and interpersonal relationships with children. No attempt was made to assess orientation to learner outcomes or the instructional strategies pertaining to them. Situations portrayed in the tests were identified as particularly challenging and representative of these dimensions of the teaching process by first, second, and third grade teachers.

1. The Word Test: The Word Test consists of 13 written descriptions of actual classroom situations which occurred in the first, second, and third grades of the Campus Elementary School (CES) at Oregon College of Education. Each written description of a situation is followed by 12 to 22 statements about the situation to which respondents agree or disagree on a five point scale (Strongly Disagree to Strongly Agree). The test provides a total score and 12 subscale scores.

2. The Film Test: The film Test consists of 13 motion picture sequences of actual classroom situations which occurred in the first, second, and third grades in CES. Each sequence is followed by 11 to 22 statements about the situation portrayed to which testees respond in the same manner as for the word test. The test provides a total score and 11 subscale scores.

3. The Simulation Test: The Simulation Test consists of 12 motion picture sequences of classroom events filmed in a single second grade at CES. The sequences are arranged chronologically to represent the events of a single day. The test is accompanied by a cumulative folder detailing anecdotal and test information for each of the "main characters" portrayed in the film sequences. Sequences were filmed in such a manner that when viewing the films the children are looking directly at the respondent. Respondents record, verbatim, their reactions to the situations and then describe (a) why they responded in the way they did, (b) what they hoped to attain through their response, (c) their impression of the child (when a single child was involved) and (d) why they responded at the time they did. The test provides a total score and seven subscale scores. Scores are derived through a content analysis of written responses.

Reliability estimates (split half) for the various subscales for the word, film and simulation tests ranged from .51 to .94, with the bulk of the scales ranging in the area of .7 and .8.

The Criterion Measures. In order to provide a rigorous test of the basic hypothesis, it was decided to use as criterion performance specific behavioral measures instead of more typically used global measures of teaching success. To this end systematic observational procedures were used as the primary data source in the study.

Performance ratings, which have plagued the field of research on teacher effectiveness, were not used. The observation system used in the two studies has recently been described by Schalock, et al. (1969).

In both the parent and replication studies the hypothesis tested was supported, that is, as tests increased in their life-likeness their predictive power increased. As indicated previously multiple correlations of .69 to .87 were obtained between predictor and criterion measures. While predictions were made on a group basis the data from these two studies offer strong support for the rationale underlying the use of situational response testing generally. As such it also provides evidence for the utility of simulation principles in educational and psychological testing as well as in instruction.

Research to be Pursued in Relation to the Application of Simulation Principles to Educational and Psychological Measurement

Granting the attractiveness of situational response tests on logical grounds, and the encouraging results that have been obtained with them in practice thus far, there are still a number of questions that need to be answered before the methodology can be applied with confidence to educational and psychological measurement problems generally. Four such problems seem primary:

1) the range of measurement problems for which the methodology is applicable,

2) the relative power which the methodology brings to various measurement tasks,

3) the extent to which situations must be sampled in order to make reliable statements about constructs or behavior in situation, and

4) the point at which a trade-off between cost of increasing the fidelity of test stimuli (setting portrayal) and the effectiveness of assessment or prediction is reached.

Suggestions for research in each of these four areas are offered in the paragraphs which follow.

The Range of Measurement Problems for Which Simulation Methodology is Applicable

One of the first steps to be taken in studying the applicability of simulation methodology in educational and psychological testing is to determine the range of constructs and the areas of prediction for which the methodology is applicable. At the present time such "taxonomy building" has not been done and as a consequence there is no clear idea of the extent to which the methodology has applicability to measurement within these fields. While this is as much a conceptual task as it is one of research it is the kind of task that needs to be undertaken early if the methodology is to have its maximum impact.

The Relative Power that the Methodology Brings to Various Measurement Tasks

Once a taxonomy of measurement tasks has been spelled out, and the appropriateness of situational response testing to these various tasks has been specified, there remains the empirical task of demonstrating the actual power that the methodology possesses. As used in the present context power of measurement is defined in terms of the utility of a measure, and this in turn is defined either in terms of its predictive or construct validity, its stability, or its sharpness in differentiating between individuals or groups on which the measure is applied. Operationally, information of this kind can be obtained only through comparing the effectiveness of situational response measures with those employing other methodologies. While such an effort is time consuming and costly, it should have high priority for the empirical base of any discipline is only as good as the measures available to it.

The Extent to Which Situations Must be Sampled In Order to Generalize or Make Reliable Statements About Constructs or Behavior in Situation

Central to the concept of situational response testing is the idea that "tendency" to respond, or actual response, is always a function of the context within which the response is to take place. As a consequence, a critical issue in the development of situational response test methodology centers on the extent to which the responses to such tests are situation specific: does a measure have utility beyond the specific situation represented by the test stimulus being responded to, i.e., do responses to specific situations generalize across situations, or are such measures limited in their utility to only those situations represented by the test stimulus? If responses do not generalize across situations then the utility of such tests is extremely limited, for as in the case of job replica tests, a test would have to be developed for each situation being predicted to or being assessed within and these are essentially without limits. Actually, the issue is probably better conceived by thinking of classes of situations being predicted to or assessed within, and samples of those situations serving as test stimuli in the measures used in making such assessments or predictions.

Within this frame of reference the issue becomes one of determining the extent to which the designer/user of situational response tests must attend to the identification of classes of situations, and then the extent to which he must attend to the sampling of specific situations within that class of situations so as to obtain a representative base against which to sample response to that class of situation. The basic assumption of such an approach is similar to that underlying much of measurement in the behavioral sciences, namely, to the extent that the specific situations that make up test stimuli are representative of the population of specific situations that define a class of situation, response to the test stimuli will be generalizable across all specific situations falling within the general class of situation being measured.

Empirically the problem becomes one of defining and testing the parameters of classes of situations and then determining the extent to which specific situations must be sampled in order to obtain a stable picture of an individual's tendency to respond to the class of situation. This rests of course upon an initial identification of classes of situations, but once this first step has been taken it then becomes possible to proceed with the empirical task. The results of this kind of effort will be the development of guidelines for the selection of situation specific settings to be used as test stimuli. Ultimately it is anticipated that evidence will accrue as to both the number and kind of specific settings that need to be included in a given measure in order to make reliable statements about the generalizability of the responses to them to other settings which differ in given ways and to given degrees.

The Relationship Between Cost of Increasing The Fidelity of Test Stimuli (Portrayal of Settings) and the Effectiveness of Assessment and/or Prediction

Generally speaking as the fidelity of test stimuli are increased (made more life-like) the cost of building such stimuli increases. One of the critical lines of research to be undertaken, therefore, is that which identifies the point of trade-off between increased fidelity, and thereby increased cost, and increased predictive or discriminatory effectiveness. Differential costs can be tolerated, of course, depending upon the significance of the measurement task to be undertaken, but even when costs are of secondary concern it is likely that in many cases increasing the fidelity of test stimuli beyond a given point will do little to increase the accuracy or power of the measure. As a consequence, one of the urgent lines of research needed relative to situational response testing is that which attempts to provide firm evidence as to the relative strengths of measurement in relation to the fidelity of test stimulus and response properties, and the cost associated with obtaining a given level of fidelity. It is anticipated that as a consequence of this line of research the users of such measures will have at their disposal fidelity-effectiveness ratios and fidelity-cost ratios, and by pooling these they will be able to make informed judgments as to the relationship between fidelity, effectiveness and cost. Given such information it will be possible for users of such measures to obtain the greatest level of measurement sophisitcation possible within the resources available.

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APPENDICES

A - Some Independent Variables and Dependent Variables in Simulation Games

B - Instructional Simulation Newsletters

C - Suggested New Directions for Games and Simulations

APPENDIX A

Some Independent Variables and Dependent Variables in Simulation Games

The following lists contain some of the common independent variables and dependent variables involved in learning game design and research. The lists are by no means complete. Yet, they do place in clear focus many factors that must be considered in both designing simulation games and conducting research on learning games.

Independent Variables

Game Variables

1. Type of objective(s)

   Cognitive
   Affective
   Psychomotor

2. Multidimensionality of objectives

   Unidimensional
   Multidimensional

3. Model on which simulation is based

   Fictional
   Real life

   Simple
   Complex

   Abstract
   Concrete

4. Fidelity to model

   High
   Low

5. Amount of skill required to win

   Little
   Much

6. Topic (subject matter)

7. Pregame strategies for winning

   Included
   Not Included

8. Intragame strategies required for winning

Simple to acquire
Difficult to acquire

9. Number of decision-making entities

Few
Many

10. Information input sources

Few
Many

Instructor
Scenario

11. Difficulty or complexity of information input

Easy
Difficult

12. Information output locations

Few
Many

Instructor
Messages from teams or players

13. Resource locations

Few
Many

Instructor
Written Materials
Other people

14. Amount of information exchanged by decision-making entities.

Little
Much

15. Importance of chance or random factors

Little
Much

16. Time

Set length
Open-ended

17. Operations required of decision-making entities

18. Game periods

One
Multiple

19. Opportunities for cheating

None
Many

20. Final score (winners and losers announced)

Given
Not given

21. Selection and modification of goals

Learner controlled
Fixed

22. Amount of trust required of players

Minimum
Maximum

23. Belief in control of destiny

Promoted by game
Hindered by game

24. Type of game

Showdown (player against system without interference from others)
Strategy (player against player with interference)
Combination (strategic exchanges before showdown)

25. Specificity of rules and context

Non-structured (free)
Highly structured (rigid)

26. Intragrame prompting

Present
Absent

Teacher specified and presented
Teacher specified, learner presented
Learner elicited

27. Referees or umpires

Present
Absent

Intervention allowed
Intervention not allowed

Player Variables

1. Number per game

2. Number per team

   One
   Multiple
   Variable

3. Age

4. Sex

5. Composition of teams in terms of age, sex, ability, etc.

   Homogeneous
   Heterogeneous

6. Number of roles per player

   Single
   Multiple

7. Permanency of team membership

   Monolithic
   Splinterable

8. Assignment of roles

Private	Voluntary
	Assigned by teacher randomly
Public	Assigned on basis of prior test

9. Equality of players (initial placement in teams, size of teams, opportunities and handicaps)

   Equal
   Nonequal

10. Mode of operation between team members

    Competitive
    Cooperative
    Mixed

11. Mode of operation between teams

    Competitive
    Cooperative
    Mixed

12. Grade in school

13. Predisposition (liking of game technique)

    Low
    High

14. Previous game experience

    Low
    High

15. Team assignment

    Voluntary
    Involuntary

16. Advisors to players

    Present
    Absent

17. Role-player characteristics, e.g., verbal ability, occupation, learning style

Player Response (Moves) Variables

1. Range of moves per player

    Single
    Multiple

2. Mode of move

    Oral
    Written
    Psychomotor (e.g., advance of pawn on board)
    Combination

3. Amount of risk in player move

    None
    Much

4. Number of contingencies involved in each player move

   One
   Multiple

5. Permanence of move

   Irrevocable
   Reversable
   Variable

6. Number of constraints involved in each move

   Few
   Many

7. Number of moves per time period

   One
   Multiple

8. Importance of move in terms of long-range influence

   Little
   Much

Move Consequences (Feedback) Variables

1. Potential for surprise

   None
   Much

2. Mode of feedback

   Oral
   Written
   Psychomotor
   Combination

3. Number of feedback inputs

   One
   Multiple

4. Potential for reward

   None
   Much

5. Potential for censure (loss)

   None
   Much

6. Control exercised by players over consequences

   Little
   Much

7. Use to determine subsequent moves

   None
   Major determiner

Briefing Variables

1. Timing

   Day before game
   Immediately before game

2. Content

   Rules of the game
   Instructions for play
   Example of play

3. Administrator

   Instructor
   Students

Game Evaluation (Debriefing) Variables

1. Timing

   Day after game
   Immediately after game

2. Person in charge
   Instructor
   Student

3. Strategy for defining

   Inductive
   Deductive
   Expositional
   Discovery

4. Length

   Long
   Short

Administrator(s) Variables

1. Number per game

2. Requisite knowledge, attitudes, or skills required

3. Type

   Instructor
   Student
   Mixed

4. Role

   Before
   During
   After

Equipment Variables

1. Time pieces

2. Scoring apparatus or helps

3. Game apparatus

   Board(s) and game pieces
   Money
   Scoring pieces
   Name tags
   Props

Dependent Variables*

1. Immediate learning and delayed learning (retention) measures

   Knowledge

   - Facts
     - Terminology
     - Conventions
     - Classifications and categories
     - Criteria
     - Trends
     - Roles

   - Strategies (win statements)

   Skills

   - Drawing analogies (matching reality with game rules and procedures)

   - Interpretation (explaining why events happen)

   - Extrapolation (predicting effects of changing one variable on other variables)

   - Application (applying knowledge to novel situations)

   - Analysis (breaking down the whole into its component parts)

   - Synthesis (building components into wholes -- redesigning a game to fit new situations)

   - Evaluation (internal-judging appropriateness or quality of strategy in game; external-judging quality of strategy in moral or ethical terms)

2. Achievement of goal

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* For elaboration of these variables, see Fletcher, Jerry Lee. The effects of two elementary school social studies games: An experimental field study. Cambridge: Harvard University, 1969 (Doctoral dissertation) and Crawford, Jack and Twelker, Paul. Affect through simulation: The gamesman technologist. Monmouth: Teaching Research Division, 1969 (Mimeographed).

3. Affectivity

- Involvement
  - Persistence of play
  - Amount of contact with instructor after game session

- Emotion
  - Measures of physiological changes

- Perception of others
  - Awareness of real-life pressures of role

- Attitudes toward subject matter
- Attitudes toward the game
- Attitudes toward the instructor
- Attitudes toward the school
- Attitudes toward other players

- Self-perception
  - Sense of control over destiny

- Interaction among players
  - Number of interacts in given time period
  - Number of conferences held by teams
  - Length of interact
  - Intensity of interacts
  - Type of interacts
  - Amount of information in written messages

- Self-perception
  - Sense of control over destiny

- Interaction among players
  - Number of interacts in given time period
  - Number of conferences held by teams
  - Length of interact
  - Intensity of interacts
  - Type of interacts
  - Amount of information in written messages

4. Time

- Length of game (and other components, i.e., debriefing)
- Speed of learning winning strategy

5. Other variables

- Number of players breaking one of game rules
- Number of times players break one of game rules
- Perceived degree of novelty of game

APPENDIX B

Instructional Simulation Newsletters

Vol. 1, No. 1
Vol. 1, No. 2
Vol. 1, No. 3
Vol. 2, No. 1

INSTRUCTIONAL SIMULATION NEWSLETTER

VOLUME 1, NUMBER 1. MARCH, 1968

Teaching Research, Oregon State System of Higher Education,
Monmouth, Oregon 97361

A REPORT OF AN U.S. OFFICE OF EDUCATION SPONSORED PROJECT, "INSTRUCTIONAL SIMULATION: A RESEARCH DEVELOPMENT AND DISSEMINATION ACTIVITY." PAUL A TWELKER, DIRECTOR.

THE PROJECT

Simulation as an instructional technique has begun to make inroads into education. Yet its usefulness possibly will be limited until several problems are solved. We do not have available guidelines for simulation design that might help developers specify what form and shape the simulation is to take. We have no clear idea of the nature or range of its application to education in general. We have little idea of what type of simulation is most appropriate for the various types of learning. If this information were available, research directions, stated in the form of hypotheses, and applications of simulation, could be identified and disseminated. This should have considerable payoff in terms of the quality of simulation techniques that are being, or will be, developed across the country.

The objectives of the research development and dissemination activity are:

(1) To continue a comprehensive search of the literature pertaining to simulation including military and industrial sources that has already produced an 848-item bibliography on simulation and related topics;
(2) To develop guidelines of instructional simulation design that will help developers in specifying the form of the simulation;
(3) To identify research directions, and state these in the form of hypotheses;
(4) To specify applications of instructional simulation;
(5) To disseminate widely the information gained.

THE STAFF

The project director is Dr. Paul A Twelker. In the last four years, he has conducted research on instructional simulation, funded by the U.S. Office of Education. Currently he is director of a program of research and development involving instructional simulation.

Assisting Dr. Twelker directly are two research associates, Dr. Jack Gordon and Dr. H. Del Schalock. Dr. Gordon has conducted research on reality as a dimension in science education, and has developed generic models of instructional systems development. Dr. Schalock has made significant contributions in the area of motion-picture testing, and is responsible for specifying research directions as well as educational applications in this area.

Also assisting on the project are a number of Teaching Research staff who are contributing their time to work on specific areas: Dr. Jack Crawford is responsible for learning games -- their application and directions for future research; Dr. Dale Hamreus is responsible for specifying applications of simulation in the area of vocational education; Dr. Ed Palmer and Sidney Micek are also involved in the "think-tank" aspects of the project; and William Hickok is responsible for the literature search.

SIMULATION (sim' yoo-lā'shan), n.

Basically, every definition of simulation takes the form of, "Simulation is a(n) ________________ of (a) _____________."
Two types of words or phrases are used in the first blank: words that connote a process and words that connote a product. In the first instance, simulation involves the individual in actually doing an activity, such as constructing, operating, manipulating, or representing. In the second instance, simulation involves a more or less tangible product such as a game or a model or a technique. The distinction essentially is between simulation as an act and simulation as an entity. In the first instance, the means or techniques involved in simulation are seemingly important in its meaning, while in the second instance, the end product of simulation is emphasized. This is pointed out in one dictionary's definition of the noun, simulation, as: (1) the act of giving a false impression, and (2) false resemblance. The distinction is also illustrated by a boy operating a model boat, in contrast to the model itself.

Several types of phrases are used to complete the definition. Essentially, they either connote an object, an action, or some information. Words such as "game", "model", "features", "structure", "reality" are commonplace. What this word is depends in large part on the subject matter or discipline in which the simulation is used.

Several examples should suffice to show the broad meanings attached to simulation. In social science, simulation may be either the constructing and manipulating of an operating model, or it may be a representation of reality. For other social scientists, simulation is the study of structures in a laboratory. In education, simulation may mean the creating of games or a model of a system. Or it may refer to a decision-making exercise structured around a model of a business operation. In biology, simulation is defined as an assumption of features intended to deceive. For the behavioral sciences, simulation is a technique of substituting a synthetic environment for a real one. Note that in this definition, there is little doubt that an act or technique is involved in contrast to a simple product. In other cases we cannot be sure what is meant without examining in detail what is simulated, how it is simulated, and for what purposes.

Harman, in his review of some definitions of simulation, states that all of the definitions have in common the characteristic of substituting other elements for some or all of the real elements of the system. He suggests that "perhaps the simplest and most direct definition of simulation is merely the act of representing some aspect of the real world by numbers or symbols that can be easily manipulated in order to facilitate study." McCormick gives a similar definition, but perhaps a little broader: "Simulation consists of some type of reproduction or representation of an actual conceptual physical object, system, process, or situation, or of a theoretical construct." Note again that these two definitions point up the two ways in which the word is used. For Harman, simulation is an act of representing, while for McCormick, simulation may be either an act of representing or a representation, depending on the interpretation given. It should also be emphasized that the fact that one person thinks of simulation as a device, while another person thinks of simulation as a technique for setting up the device, is not undesirable. It simply points up the two accepted meanings of the word.

In summary, simulation may be thought of in general terms as: (1) a technique of modeling (physically, iconically, verbally, or mathematically) some aspects of a real or proposed system, process, or environment, or (2) the model (physical, iconic, verbal, mathematical) of some aspects of a real or proposed system, process, or environment. The usage which might be adopted by an individual would depend largely upon his discipline, and the use to which the simulation is put. The three uses of simulation that seem to account for most applications, are: (1) generation of information (research); (2) generation of new objects, processes, or systems (development); and (3) communication of information (instruction).

A BIBLIOGRAPHY AND A FILM

An 848-item annotated bibliography and a documentary film have been published by Teaching Research, in cooperation with the Northwest Regional Educational Research Laboratory. Included in the bibliography are topics directly related to simulation and man-machine systems. Some of the topics listed in the index include:

Artificial intelligence
Computer simulation
Games
Human factors research
Man-machine systems
Models
Simulation

This 220-page document is available from Teaching Research in limited quantities for $3.00 or through ERIC.

Also available is a 45-minute film, "Of Men and Machines". This film presents highlights from a series of conferences on man-machine systems that was held in the Pacific Northwest last year. This 45-minute film explores three vital issues. . . deciding what to teach, so today's student really learns what he needs to know; motivation, so the student attends to what is being taught; the teacher's role, so today's teacher may keep in step with what is demanded by the technological innovations.

The film discusses topics such as...
- learning games
- instructional program development
- computer-assisted management of instruction
- the technological revolution

"Of Men and Machines" will be loaned free to educational institutions and other qualified groups (waiting period: up to 5 months), or rented at $25 (waiting period: up to 4 weeks).

A FIELD TRIAL

Teaching Research is currently engaged in a field trial of new low-cost instructional simulation materials for teacher education. Representatives from 10 institutions selected from across the country recently met in Monmouth to study the new materials in preparation to implementing the use of new materials on their respective campuses. The ten institutions and their representatives participating in the field trial are:

Institution	Representative
Michigan State University	Robert Schmatz
Oregon College of Education	Robert Albritton
University of Texas	O. L. Davis, Jr.
West Virginia University	Jack Bond
University of Oregon	William Lacey
Shippensburg State College (Pennsylvania)	Paul Beals
Illinois State University	Arnold Slan
Brigham Young University	Hugh Baird
Kent State University	James Phillips, Jr.
State University College at Brockport (New York)	Glen Stofka

The materials which cover classroom management as well as discovery teaching are not available for general distribution until after the field trial. We anticipate that the classroom management package will be available for general use early in 1969.

AERA SPECIAL INTEREST GROUP

At the AERA meetings in Chicago in February, a special interest group on Simulation Systems was organized by Dr. Donald Cruickshank of the University of Tennessee. Individuals whose interest in simulation ranged from using it as a research tool to using it for instruction were on hand to form the new group. From all indications, this group will be quite active and promises to offer a means of keeping members informed as to what is going on in the field as well as giving them a means whereby important theoretical questions may be fielded and discussed.

Dr. Donald R. Cruickshank was elected chairman of the newly formed group, and Dr. Paul A. Twelker was elected secretary-treasurer. Application blanks may be secured from either of these individuals. A $1.00 membership fee should accompany all applications.

INSTRUCTIONAL SIMULATION INSTITUTE

A unique institute experience will be offered by Teaching Research this summer, made possible through funding from the VI B Higher Education Act. The four week institute, entitled Instructional Simulation for College Instruction has as its objectives: (1) to train participants in the design and use of instructional simulations, (2) to disseminate information from the research development and dissemination activity; (3) to produce take-home training materials so participants may act as "change-agents" in their local environment, and (4) to give the project staff an opportunity to evaluate and revise models of simulation design previously developed. Participants to be eligible must hold a teaching position with a 2-year or 4-year institution of higher learning. Eligibility will be determined on the basis of several criteria: (1) interest in instructional simulation, (2) potential capability of appropriately applying simulation in the participant's own area, and (3) interest in improving his own instruction. Minimal experience in educational media is needed for the institute. More information may be secured from the institute director, Dr. Twelker.

THE NEWSLETTER

This newsletter is the first of four issues reporting the activities of the instructional simulation program at Teaching Research. Future issues will highlight topics that have been alluded to in this issue. Please address inquiries and suggestions to the project director. If you have available any recent papers or reports involving simulation, the project staff would be most pleased to receive a copy for inclusion in our forthcoming bibliography supplement.

INSTRUCTIONAL SIMULATION NEWSLETTER

VOLUME 1, NUMBER 2. JULY, 1968

Teaching Research, Oregon State System of Higher Education,
Monmouth, Oregon 97361

A REPORT OF AN U. S. OFFICE OF EDUCATION SPONSORED PROJECT, "INSTRUCTIONAL SIMULATION: A RESEARCH DEVELOPMENT AND DISSEMINATION ACTIVITY." PAUL A. TWELKER, DIRECTOR.

SIMULATION INSTITUTE WELCOMES 33 PARTICIPANTS

The "Simulation in College Instruction" institute welcomed 33 participants in the opening session, Monday, July 22. Preparation for the institute has been under way for the last four months. It already has received such an enthusiastic response that we plan to make available an instructional simulation kit that includes the institute manual and resource lists used during the institute. The institute staff has been collecting simulation materials from around the nation to demonstrate and display during the institute. Scores of new simulation exercises have been catalogued. Other materials include slide/tape presentations of interviews with three of the leading developers of Educational Games: Abt Associates Inc.; The Department of Social Relations (Coleman, Boocock, et al.), Johns Hopkins; and Nova Academic Games Project, Fort Lauderdale, Florida. The presentations review both current developments and the approaches to simulation used by each group. Another interview with Richard Braby of the Naval Training Device Center describes the NTDC orientation to designing military training devices, and the uses of simulators for instructional purposes.

NEW BIBLIOGRAPHY FORTHCOMING

As the annotated bibliography, "Instructional Uses of Simulation: A Selected Bibliography" is now out of print, the program staff is working on a completely revised and updated bibliography to be published late this summer. This new document will be devoted exclusively to simulation, and will include an author index and simulation game index, in addition to a subject index. The staff is revising the format of the document in order to make it easier to read, and will include special index notations to make it easier for an individual to find references of general interest. Over 500 new references will be included. Simulation exercises and games will be referenced in a separate section for ease of use.

VIDEOTAPE ON CLASSROOM SIMULATION NOW AVAILABLE

The classroom simulation technique developed at Teaching Research which has been used for eight years as a research training vehicle, is now demonstrated and discussed in a half-hour videotape. For some time, the staff has had to rely on written reports to describe the technique. The new videotape, produced by KOAP-TV, (Oregon Educational Broadcasting, Portland, Oregon) includes interviews with two professors who have used the technique in their classes, as well as interviews with students who have been trained. The videotape is available for use on 1" Sony machines.

SIMULATION: WHAT IS IT? WHY IS IT?

A paper with this title was presented to the Association for Supervision and Curriculum Development by Dr. Twelker. It covers the rationale of simulation for instruction and some crucial psychological and philosophical assumptions underlying the concept. Copies of the paper are available upon request. Other papers presented at the ASCD meeting in San Diego include "Simulation: Status of the Field" by John R. Raser (University of Michigan, Ann Arbor), "Simulation and the Individual" by Cleo Cherryholmes (Michigan State University, East Lansing), "Simulation and the Group" by Gerald Zaltman (Johns Hopkins University, Baltimore), and "Schooling as a Series of Simulations" by O. L. Davis, Jr. (University of Texas, Austin).

SIMULATION: FAD OR FIASCO

Most individuals, when asked about the use of simulation for instruction, will say that simulation has enormous potential. They point out that the novelty and the excitement created by simulations of various kinds, especially the familiar academic or learning game, is unparalleled in most educational circles. With this statement, there can be little disagreement. Cleo Cherryholmes, in his review of six investigations of educational simulations, concluded that simulation produced increased student interest. Our own observations confirm this evidence. One student was asked, "Did you do more homework than usual to play the game?" The student answered with the puzzled look, "Gee, I never thought of it as homework." Although anecdotes do not prove a point, they do serve to point up the power of simulation in individual instances.

Yet, there are individuals who have used simulations, specifically games, for some time who are expressing disappointment with the technique. For these individuals, the suggestion of Walter Cronkite in a CBS documentary that "an otherwise dull subject becomes fascinating and unforgettable to the students" is greatly oversimplified. Some would state that data reveal that games are not more effective than conventional instruction, and that the in-class time required to play the game is unnecessarily lengthy and unrewarding. Others point to the "knowledge gap" which prevents students from playing an assigned role which may be unfamiliar in a realistic and meaningful manner. Some would point out that games probably teach very little, and what is taught is not an accurate or fair representation of the real world.

The problem that confronts designers and consumers of simulation alike is that the technique is being exploited faster than technology can: 1) provide workable guidelines for simulation design, and 2) provide guidelines for simulation use. Lets take a closer look at the first point. Contrary to some claims, we do not have workable models of simulation design that are meaningful to the layman and that enables him to personally design a simulation, whether he be an elementary school teacher or a college professor. Phrases such as "time area-function-bounded problem space", "pay-offs" and "static and dynamic system elements" simply do not communicate. Time and again, individuals attending conferences or workshops on simulation express their inability to "get started", and they don't. One person expressed it this way: "Do I have to wait for commercial outfits to produce simulations? If not, how do I start to design one? Who can help me? What is available that will lead me step by step through the process?" The Simulation Systems Program at Teaching Research is now developing guidelines that will fill this gap.

The second point needs little explanation. Data are being compiled at a fast rate that show the importance of using a simulation correctly to maximize benefits. The number of game players, the set given to students as they begin the simulation experience, instructor interference, and the way the debriefing is handled are crucial factors. Yet, few games give enough meaningful guidelines to help the teacher. Further, many manuals that are available do not state in detail: 1) the objectives in operational terms (behavior responses of students); 2) the value of the objectives, and how simulation fulfills these objectives in part or in whole, 3) the way in which the simulation should be interrelated with other course activities, 4) the evidence to document the effectiveness or efficiency of the technique, both in terms of specified objectives as well as unintended objectives, 5) the qualifications of the teacher, 6) the entry level of the students, and other essential information.

The title, "Fad or Fiasco", expresses a negative viewpoint. No alternative is given except two degrees of negative outcome: simulation may come and go as a fad, and make little impact on education, or simulation may be exploited to the point that it becomes a fiasco to be lived down by those in the field. The personal bias of this writer is that the simulation movement, if indeed it is that, is past the fad stage. Commercially-oriented firms are selling simulations about the country. Yet, little evidence accompany these products that give their limitations, their use, and their potential. Testimonials in place of hard data are common. One major reason for this situation is that the objectives of the simulation are not clearly in the designers mind when he designs the product. This writer has heard designers say, "Our results didn't show anything, but it wasn't the simulation's fault. We just didn't measure the right thing."

Is simulation a fad on verge of a failure? No. In spite of the rather pessimistic view given above, what will be learned about simulation in the next few years to come will establish a firm data base to guide the development and use of the technique in well-founded, stable ways. The "fiasco" of programed instruction a decade ago did not destroy the technique, but strengthened it to the point that it has taken its place as an instructional logistic that may be most effective and efficient, appropriately applied. Untried or ineffective simulations may come and go, but the enormous potential of simulation will not be lost.

Paul A. Twelker

WHAT TO DO UNTIL THE PROPHETS PRODUCE (or, how to integrate presently available learning games with existing course activities and objectives)

The proliferating ooze of simulations into education, primarily as learning games, is being paralleled by a smaller but accelerating flow of criticism and exhortation. Most of these exhortations, toward improved designs and thorough evaluations of new games are well taken. Particularly, our own.

Unfortunately, the exhortations far outnumber any noticeably improved games. This gap between the identification of inadequacies in present learning games and consequent improvements (the great game gap) is likely to persist for some years. Sarane Boocock estimates that approximately one year is required for the Johns Hopkins group to produce a single game. And their games, while certainly among the better learning games yet available, do not meet sophisticated standards of evaluation. Experience in game development in our own shop adds weight to the prediction that substantial improvements are coming--eventually. During, say the next two years, any extensive instructional use of games must be confined to games not appreciably better than those now existing.

What are the parameters of existing games? To briefly summarize the salient characteristics of present learning games, in just one area such as social studies, demands some crass overgeneralizations. These would include:

> The learning objectives of existing games are not clear. Typical measures of learning, i.e., recall of principles, recognition of concepts and examples, indicate that games are

not more effective than other methods. But neither are they noticeably less effective. Involvement and interest is high, far higher than that produced by lecture, discussion, etc. Games take time, and more material can be "covered" by other methods. In short, the employment of games to achieve typical learning outcomes alone is questionable, their employment for motivational purposes is probably well taken.

Plausibly then, games could be used profitably to motivate or re-charge the interest of students. The students would learn primarily through other instructional techniques, e.g., reading, reporting, library search, etc. The rub, is that the existing games are rarely designed to explicitly propel learners into further reading, etc. The effective instructional program integrating games with other learning activities is yet little more than a gleam in designers eyes. The use of present games as a direct springboard to other forms of learning requires certain rough carpentry by the instructor. The following stop-gap procedures are suggestions for attaining such a springboard effect. Most of these bridges e.g. game to library have been tried by our staff and by others. They may alleviate until the real help (adequate instructional development of integrated materials, procedures, and programs) arrive.

Within The Game Itself

1. Confrontation with reality.
   Instructor identifies a problem from the context of desired learning material. The problem is transposed to the game setting. Then, instructor confronts game players with this additional problem, derived from the material to be learned. Players must develop coping strategies based upon an information search through the material.

2. Building scenario and role portraits.
   Transpose setting of game so that scenario and roles will be integrated with desired learning content. Game players must then develop explicit background for teams and/or roles for players based upon the instructional materials.

3. Developing a prediction.
   Using a situation or move made during the game, the instructor requires that players make a prediction of the probable consequences. The basis for prediction (factual, conceptual, or principle rooted) is contained in the other instructional materials. Players must conduct a search through the materials to arrive at a prediction.

Post-Game

Since we are enumerating ways to utilize an existing level of motivation, post-game moves only will be described.

1. Comparing the game with the other material.
   A critical analysis of the instructional material posed upon perspectives gained during the game. The players identify and compare resources, roles, tactics, outcomes, principles involved, etc. in the learning material with those encountered in the game.

2. Designing a new game for the instructional material.
   The players use the material as a basis from which to construct a game of their own design. The instructor can unobtrusively emphasize the incorporation of those principles and concepts to be learned. If building and playing the new game threaten to bench the intended learning, the design may be limited to initial specifications.

3. Incorporate the other material into game de-briefing sessions.
   The additional instructional material may be utilized as a basis to:

   a. identify limitations in the game

   b. highlight unique or significant moves made during the game

   c. identify examples illustrated during the game

   d. suggest alternative strategies

   e. extrapolate to consequences not explicitly dealt with by the game.

If you know of better stop-gap moves, write us, and we will publish your suggestions (under the name you supply). We will also present an "Instructional Simulation Kit", referred to elsewhere in the newsletter, to the suggestion judged the most innovative and/or useful by our barely biased staff.

Until the programmatic becomes product,

Jack Crawford

INSTRUCTIONAL SIMULATION NEWSLETTER

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Teaching Research, Oregon State System of Higher Education,
Monmouth, Oregon 97361

A REPORT OF AN U.S. OFFICE OF EDUCATION SPONSORED PROJECT, "INSTRUCTIONAL SIMULATION: A RESEARCH DEVELOPMENT AND DISSEMINATION ACTIVITY." PAUL A. TWELKER, DIRECTOR.

GIVING SIMULATION A GOOD START

The October, 1968 issue of Readers Digest relates the story of a mother of a kindergarten-aged daughter who was apprehensive about answering all the personality and social-development questions on the registration form. Upon meeting a neighbor who also was registrating her boy for kindergarten, she asked the woman her feelings about the questinnnaire. The reply came back, "I'm torn," she said, "between telling the truth-or giving him a good start."

As instructors and administrators seek information about simulation, especially learning games, and their potential for solving certain instructional problems, those in the position of providing these answers have a problem somewhat akin to the woman above. They can either give simulation a "good" start in the particular class or school, and gloss over some of its very obvious problems, or they can "tell the truth." For example, they can point out that few available instructional simulations can be counted on for producing desired outcomes on the part of the learner. In many cases, these outcomes are not even stated. They can state only roughly the ways in which simulation is best used. They can point to the lack of empirical research on the issues related to fidelity, learning outcomes, and simulation design specifications. They can state that the success of the simulation game is dependent to a large extent on the skills of the administrator, especially in the matter of post-evaluation or debriefing.

As the staff's experience with workshops in public schools grows, we find that candid expressions of both the pros and cons of simulation games do not dim teachers' acceptance. Teachers need to be leveled with when innovations are examined. In fact, one might even hypothesize that the more an instructor is aware of these factors, the better he is able to use the game and be capable of on-the-spot improvision that is so necessary. In summary, we feel that the best start that simulation can be given is to tell the whole story and point out its weaknesses, and its unknowns as well as its merits.

NEW BIBLIOGRAPHY DELAYED

The publication of the new bibliography, "Instructional Simulation Systems: An Annotated Bibliography" has been delayed. The program staff now estimates that it will be about March 1, 1969 before copies are available. It is being published by the Division of Continuing Education (Corvallis, Oregon).

SIMULATION: STATUS OF THE FIELD

A paper with this title was presented in Boston to the Association for Supervision and Curriculum Development by Dr. Twelker. The paper discusses the use of simulation in non-school settings, and the implications to public school education that these activities offer. Copies of this paper are available upon request.

Other papers presented at the ASCD meeting include: "An Introduction to Simulation Activities" by Audrey Suhr (Johns Hopkins University); "Simulation and the Group" by Martin Gordon (Art Associates, Inc.); and "Simulation: Looking toward the Future" by O.L. Davis, Jr.(University of Texas, Austin).

The following article on simulation trainers was exerpted from the ASCD paper by Dr. Twelker.

SIMULATOR TRAINERS

In the military, the word "simulator" is commonly associated with equipment. Often, these "machine-ascendent" simulators require a team of operators rather than just one, and are called "systems simulators." Many are multi-million dollar devices, and are mediated by an electronic computer. Some have estimated that there are over 3,000 different types of simulators used currently by the military and commercial aviation. Expenditures on prototype simulation devices are set minimally at $27 million annually. Listed below are several names of simulators that serve to illustrate the variety of training functions served by simulation.

Simulator, Small Arms, Flash Noise
Shipboard Universal Radar Land Mass Simulator
Sonar Simulator
Submarine Simulator, Universal
Talos System Shipboard Simulation Equipement
Target Generator, Three Dimensional, Airborne Simulator
Helicopter Flight Simulation
Height Finder Target Simulation
Fire Control and Launcher Simulation
F8U-1 Operational Flight Simulator Trainer

The evolution of computer-mediated simulator trainers has been significantly speeded by groups such as NASA in its efforts to provide a training capability for manual space flights. Most of these simulators represent a sophistication of man-machine adaptive and responsive environments. Kristy (1967) describes a training environment that staggers the imagination of those who spend most of the time in front of a chalkboard talking to students. The Simutech Trainer was conceived of to train Air Force electronics technicians in a manner that provides tutorial teaching capabilities and realistic on-the-job experience. The specification of the system which Kristy describes calls for computer controlled programed learning to integrate several types of display: (1) animated schematics, (2) textual and diagrammatic teaching material that includes quizes and branching sequences. A high-speed, quick-access, videotape presentation system provides informal lectures, "cookbook" advice, and tutorial support for the student. All this is linked with a simulation of an electronic system which the student is responsible for maintaining. This system, linked with the computer, senses and responds to the student's maintenance actions. Another component in the trainer system is a simulation of the "operations room" of an Air Force site. This is accomplished by a "squawk box" communication tie between the operator and the maintenance room. With this system, the student:

(1) can receive video instruction on fundamentals of electronics;

(2) can receive clarification and reinforcement from the computer-controlled programed instruction console;

(3) can practice what he has learned by performing "on the job" by means of the simulated hardware;

(4) can receive remedial help when he wishes or when the computer deems it necessary;

(5) can be quizzed on his progress;

(6) can proceed at his individual pace;

(7) can be monitored so as to inform instructors of his progress and difficulties to examine during small, live-group sessions.

From studies of the efficiency of computer assisted instruction and simulation training, it is estimated that training time may be cut by two-thirds using this equipment. If the system is implemented to accomplish electronics training in the Air Force, the cost would be about $130 million. Although this cost represents a huge sum, Kristy points out that if the trainers were capable of actually reducing training time by two-thirds, the Air Force would save a large fraction of the funds expended on training, and these savings would pay for the System engineering, hardware development, and installation costs of $130 million in only 18 months. Thereafter, the Air Force would save in training costs up to $75 million per year.

Implications to education. The civilian application of simulator trainers is discussed in detail by Kristy (1967, pp. 118-122). In summary, several important points are made:

(1) The major area of application appears to be in large federal training and retraining programs;

(2) On-the-job training seems necessary for retraining efforts, but poses serious problems;

(3) A high-efficiency training system such as the Simutech Trainer can provide simulated "on-the-job" training;

(4) The application of the Simutech Trainer to the federal programs would occur simultaneously with its application in industrial training programs;

(5) The application of the system to vocational high schools has serious problems with respect to the large capital investment required.

Regarding the last point, Kristy shows that the cost of training students in an optimal installation in six to ten different technical areas might run $450 per trainee per year, figuring a 10-year period to amortize the captial investment. This is two or three times the average investment in training students. Do the benefits or potential of such devices as the Simutech Trainer demand such expensive training? Is it necessary to build a "simulator-trainer-tutorial environment" that even senses human actions to a sensitive degree and presents "diverse, alternative programed situations leading toward teaching and learning objectives?" Can we afford to lose a quarter or more of our youngsters as dropouts who possibly might be sufficiently motivated in such an environment to continue with their education? It is estimated that "if the present rate of dropouts continues, there will be 32 million adults without high school diplomas by 1975" (Arthur D. Little, Inc., 1968, p.11).

Indications are that there is rising concern over the steadily widening gap between the nation's manpower requirements and the capabilities of the available manpower pool. It has been predicted that "substantial" government support for manpower development programs will continue. How much is spent for civilian institutional training and on-the-job training? It is estimated that about $286 million for institutional training and $54 million for on-the-job training is spent under funding from the Manpower Development Training Act of 1963 (Arthur D. Little, Inc., 1968, p. 12). Even if the estimated $1.3 billion expenditure of Office of Economic Opportunity funds for equipment and materials in training programs are added, the total cost would hardly exeeed $1.7 billion annually, while the training costs of the Department of Defense for military personnel total approximately

$4 billion per year. It should not be necessary to say more about the comparison of where "substantial" support is going!

What does the military think about simulation? The Arthur D. Little, Inc. report (1968, p. 13) states that:

> "The growing emphasis on cost/effectiveness in military training programs will result in much greater use of simulation training. NTDC personnel suggest that the use of simulation is in its infancy and that there may be almost total dependency on simulation in several training areas in the not-too-distant future. Typical areas which lend themselves to simulation techniques are cockpit and operational flight training, in-flight training, and training in electronic warfare and weapon systems.
>
> In order to teach personnel to operate in the conceptual, psychophysical environments of the present and those anticipated for the future, new technologies are used to simulate such environments visually. A simulator involves any one or a combination of the training environment, computing and associated simulation systems, and instructor station and display systems. Electronics and optics represent major elements in the fabrication of a simulator. However, the market is not limited to electronics and optics companies; industrial organizations having educational technology capabilities should realize a considerable share of this market."

Will the military experience in simulation be translated effectively to the education of civilians in school settings? Few simulators have been used in occupational education. The factors that preclude rapid adoption center around three areas:

Expense. Few schools have the capital to invest in these complex simulator systems, even if it were shown that training time could be drastically reduced and that the system could pay for itself in a reasonable period of time. It has been estimated that the cost to provide electronic equipment to one child per year is $250 vs. $8 per year per child for texts (Arthur D. Little, Inc., 1968).

Insufficient cost/effectiveness data. This might be the major problem with complex systems such as the Simutech Trainer in civilian applications. The very great cost advantage where high efficiency training is desired and economically necessary has yet to be proven.

Slowness of acceptance. Educators are a conservative lot, and the supposed "dehumanizing of education" poses a threat to innovation. In fact, machine-ascendent simulation does not dehumanize instruction, but places in the hands of the student a learning environment that is quite similar to the operational world in which he will have to subsequently operate.

The Little report indicates that it will probably take fifteen years before computer-assisted instruction is accepted and used by the majority of the elementary and high schools in the nation. In 1967, only three school systems were experimenting with CAI. It is doubtful that machine-ascendent simulation will have an impact that is greater, although this writer hopes that his pessimism is unwarrented.

THE DESIGN OF INSTRUCTIONAL SIMULATIONS

In designing an instructional simulation system, or any instructional system for that matter, it is useful to think of a gap -- a difference between the learner where he is before instruction, and after instrution. Before instruction, we assume that he lacks some knowledges or skills necessary to perform satisfactorily in an operational situation. After instuction, we assume that he possess these skills. Our problem is to specify the learning conditions necessary to bridge this gap between the learner's initial repertoire and final criterion repertoire.

How best are these instructional conditions specified? Are there instructional methods effective in all kinds of learning activities? To be certain, there are some general rules-of-thumb that seem to hold in a variety of conditions, such as the provision for proper feedback, active participation, spaced practice, and so forth. Yet, it is clear that these guides do not lead us far enough down the road of instructional specification to be of much help at this stage in our technology. Too many decisions must be made in the course of specifying instructional conditions that cannot be answered by examining past research, theory, or intuitions. Decisions must be made in the best manner possible, and this requirement has in large part prompted the approach to be discussed in detail below. This approach may be summarized as:

(1) Determing what shall be taught?
(2) Determining how it might be taught?
(3) Validating the system.

As a systems approach to instruction, the systems designer (or "instructional engineer") has the task of creating and sequencing a series of learning experiences which will produce a previously stated behavior(s) on the part of the learner. To achieve this, the first thing the systems designer does is to define the instructional objectives or desired terminal performance outcomes. When a designer states what he wishes the student to learn in behavioral terms, he not only provides a means for looking at the instructional content in a facilitative manner, but he also provides a means for determining the criterion measures required to test whether or not the students have learned. By specifying the instructional content in behavioral terms, the designer provides himself with information that pertains to the design of instructional methods. The instructional methods and materials, when implemented according to some administrative plan, become the instructional program -- after exhaustive tryout and revision. At the completion of instruction, criterion measures are applied to obtain an indication of the adequacy of the program. An integral step in the development of the new system is the provision of self-corrective feedback all along the way that is used to modify the system if the desired effects have not been achieved. The learning experience is continually monitored and empirically tested until effective.

The rationale above has been stated in general terms to point up the fact that a simulation experience should not be conceived of as an isolated experience taken out of the context of the overall instruction. The term, "simulation systems" infers that the simulation component of the system is accompanied by other (non-simulation) components. The components describe what curricular units precede, accompany, and follow the actual simulation exercise. Also, the word "system" connotes an interrelated set of components ranging from media and manuals to student learning materials.

. . .

In the next issue, the discussion of simulation system design will be continued. A flowchart summarizing the design model will be presented, and each step will be briefly discussed.

INSTRUCTIONAL SIMULATION INSTITUTE REPORT

From the third-party evaluation, it was concluded that the "Simulation in College Instruction" Institute held this summer by Teaching Research was a "robust" institute. The program aided participants in generating some 28 instructional simulation packages. Several examples of the packages are listed below:

Self-Perception Game
Ghetto
Naval Sea and Air Engagement
The Game of Conversational "leading"
College Activities Game
Teacher Time Allocation Simulation
Freshman Orientation Simulation
The Game of Self-Defense
Educational Problems Simulation

It is obvious that futther institutes of this type should be conducted. Already, inquiries are being received about other institutes on simulation. A proposal has been submitted to EPDA which represents an amplification of the approach used in the recent Institute. The amplication includes, in addition to the regular four-week institute, an eight-week institute for trainers, a regional program for community college staff, and an expanded follow-up program for all participants. For those who are interested in the specific program and details of the recent Institute, a limited number of final reports are available at $2.00.

SIMULATION FOR TESTING

An important use of simulation that should receive increasing attention is that of testing. Teaching Research has been actively researching this area, largely through the efforts of Dr. H. Del Schalock. In the paper below, Dr. Schalock outlines some of his thoughts about situational response testing.

SITUATIONAL RESPONSE TESTING: AN APPLICATION OF SIMULATION PRINCIPLES TO MEASUREMENT

Situational response testing, though called by other names, has had a long history. Teachers have required students to demonstrate problem solving skills by applying them to described situations since time immemorial. "Job replication" tests have been used in industry and the military as a basis for selecting personnel since the first world war. Projective tests like the T.A.T., which require response to pictorial representations of life settings, have been in existence for 30 or more years. Simulated clinical problems are now being used in medicine as a basis for determining whether prospective physicians possess the clinical competencies desired by the profession (McGuire and Babbott, 1967). All of these approaches to measurement can legitimately be classified under the heading situational response testing since they are characterized by test stimuli which represent some aspect of a real-life situation.

Because of their linkage to real-life settings situational response tests are particularly attractive as predictive measures. There is a common sense appeal about the use of measures for predictive purposes that sample the behavior to be predicted in a situation representative of the situation to be predicted to. In spite of such appeal, and in spite of the fact that situational response tests are as successful as predictors as any other measures available to the behavioral scientist, they have still fallen short of the predictive power desired of them. Rarely can one find a predictive scheme sufficiently powerful to account for more than half of the variance in a criterion involving complex human behavior. This is the case whether the behavior is academic achievement in college (Cronbach, 1960), routine job success, or occupational choice and satisfaction (Ghiselli, 1955). Even less variance in criterion behavior can be accounted for when predicting to such complex phenomena as performance in public school teaching (Mitzel, 1960), clinical psychology (Kelly and Fiske, 1951), or various air force activities (MacKinnon, 1958). As yet, the major part of human behavior and performance simply cannot be predicted with an accuracy approaching phenomena in the physical sciences.

One factor that complicates the use of situational response tests as predictors, and undoubtedly affects their power in that role, is the fidelity of test stimuli and responses used, that is, the degree to which test stimuli represent the reality of the situations they are intended to represent and the degree to which the responses required in the test situation represent the reality of the responses required in the real-life situation that is being represented. Using a verbal description of a situation as a test stimulus, for example, offers a different level of representation than does a photograph, or a motion picture. Similarly with test responses. A response that requires agreement or disagreement with statements made about a situation portrayed, offers a different approximation to real-life behavior than does a verbal or written description of *how one would respond if he were in the situation*, or a *simulated* response to it, that is, the way one would actually respond within a simulation of a situation. A reasonable hypothesis to be drawn from these observations is that as test stimuli and test responses increase in fidelity, i.e., increase in their approximation to the characteristics of real-life situations and responses, the predictive power of situational response tests should increase.

A study by Schalock, Beaird and Simmons (1964) tested this hypothesis. Four predictor tests, varying on a continuum of stimulas and response complexity, were used in the study: 1) a traditional paper-and-pencil attitude scale, where the test stimulus was a statement describing an orientation to the teaching function and response was defined by agreement or disagreement to the statement (The Minnesota Teacher Attitude Inventory), 2) a situational-response test where the test stimuli were written descriptions of filmed classroom situations and response was defined by agreement or disagreement to statements made in relation to the situational descriptions (The Film Test), and 4) a situational-response test where the test stimuli were also motion picture sequences of classroom situations but the response was free, i.e., the subject responded to the filmed situation *as if she were the teacher in the situation* (The Simulation Test). It was hypothesized that the predictive power of the tests would vary in the order of their listing above, with the MTAI being the weakest predictor and the simulation test the most powerful. The relationship of these tests to one another on a continuum of stimulus and response complexity appears as Figure 1.

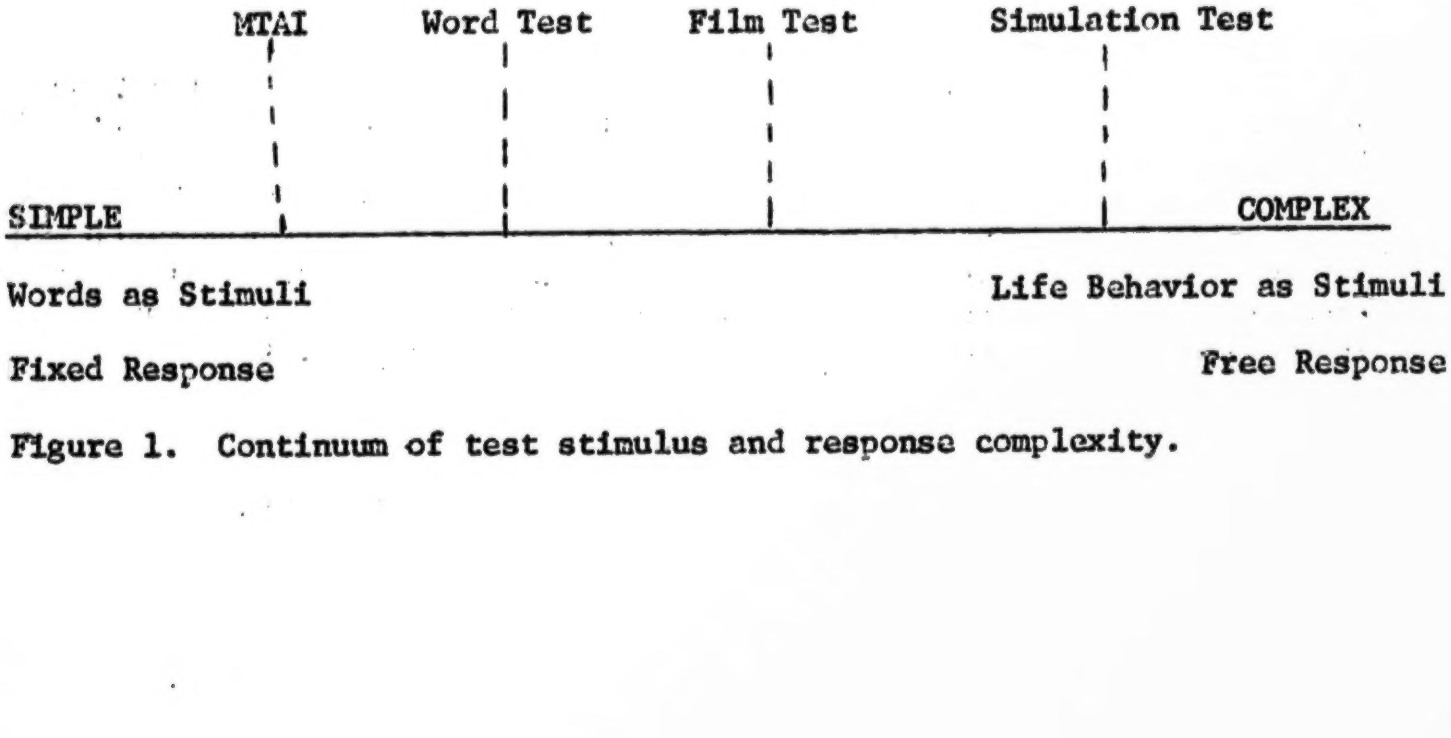

Figure 1. Continuum of test stimulus and response complexity.

The behavior predicted to in the study was the ongoing classroom behavior of student teachers. All four predictive measures were administered prior to student teaching; fifteen independent measures descriptive of teaching behavior were obtained for each teacher during the final two weeks of the student teaching experience. The TEACHING RESEARCH system for the Description of Teaching Behavior in Context (Schalock, 1967) was used in obtaining criterion measures. All such measures were based upon six 1/2 hour periods of observation on each of 40 student teachers teaching in 1st, 2nd, and 3rd grade classrooms.

By and large the data that derived from the study supported the hypothesis. Percent of criterion variance accounted for in each criterion measure ranged from 49.0 to 75.7 with a mean of 58.8. The L test for ordered hypotheses was significant for these data at the .05 level, with the Simulation Test subscales consistently outranking the other predictors in accounting for criterion variance. The MTAI consistently ranked last, with subscales of the Word and Film Tests accounting for essentially the same amount of variance in the criterion measures. More important perhaps was the amount of variance that was able to be accounted for in the various criterion measures by the predictors. As indicated above, studies in the behavioral sciences have rarely been able to account for more than 50 per cent of the variance in any criterion that has been predicted to, and when the criterion has been as complex as teaching behavior the level of prediction has nearly always been less. In the Schalock, Beaird and Simmons study at least 50 per cent of the variance was accounted for in each of the 15 separate criterion measures used (concrete behavior of teachers in the classroom) and as much as 75 per cent of the variance was accounted for in some. The study has been replicated with both student and experienced teachers (Schalock and Beaird, 1968), and while the hypothesis as to stimulus and response fidelity was not as clearly supported as it was in the first, and results varied to some extent for beginning and experienced teachers, the magnitude of the correlations between predictor and criterion measures were maintained.

While a great deal of work must still be done to develop fully the potential of situational response testing, the work done thus for clearly identifies the methodology as one of the most promising in the repertoire of approachs to measurement in the behavioral sciences. This should represent an open invitation to those working in the area of simulation for the methodology of simulation is basic to the methodology of situational response testing. Without question, one of the major applications of simulation in the future will be in the area of measurement.

H. Del Schalock

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INSTRUCTIONAL SIMULATION NEWSLETTER

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Teaching Research, Oregon State System of Higher Education,
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A REPORT OF AN U. S. OFFICE OF EDUCATION SPONSORED PROJECT, "INSTRUCTIONAL SIMULATION: A RESEARCH DEVELOPMENT AND DISSEMINATION ACTIVITY." PAUL A. TWELKER, DIRECTOR.

REPORT NOW IN PRESS . . . AVAILABLE MARCH 1

The report, Instructional Simulation: A Research Development and Dissemination Activity, is available for $3.00. The report is a culmination of 18 months of exploration into crucial issues of simulation research, application, and design.

The chapter, Simulation: An Overview (by Paul A. Twelker), furnishes the reader with a broad look at the field of simulation, and provides a rationale and conceptual frame for subsequent discussions. It examines many of the more important issues in the design and use of simulation.

In The Design of Instructional Simulation Systems (Jack Crawford and Paul A. Twelker), the authors examine how several simulation centers around the country look at simulation design, and then present the approach taken at Teaching Research. A thirteen step model of simulation design is described.

The chapter entitled Instructional Simulation: Past, Present, and Future (Paul A. Twelker), examines the application of simulation in school and non-school settings. Examined are some uses of simulation in the military, business, and government. Implications of these applications to civilian education are discussed.

Two other chapters concern themselves with research directions and application. In Simulation in Vocational Education, (Dale G. Hamreus) important contributions of simulation from the military in vocational training are discussed in light of civilian occupational training. Second, special attention is given to the use of simulation for measurement purposes in Situational Response Testing: An Application of Simulation Principles to Measurement (H. Del Schalock).

THE DESIGN OF INSTRUCTIONAL SIMULATIONS

In the last issue of the Newsletter, the rationale was presented for the design of a simulation system. In this issue, the thirteen phases of simulation system design will be summarized. Detailed step-by-step explanations are beyond the scope of this paper, but are available elsewhere (Crawford and Twelker, 1969).

Specific Steps in Instructional Simulation System Design[1]

Step 1. Define instructional problem

Before one can improve instruction, he must step back and examine in broad terms what preceded his decision to develop a new instructional system, and what might follow if his intentions were realized. What condition has motivated his tampering with the status quo - why does he believe that intervention can improve the conditions? What is the problem? What are the proposed solutions to the problem? What information led to the definition of this problem? In addition to defining the problem, the designer should make a thorough analysis of the context in which the system is to operate.

Step 2. Describe the operational educational system

Why analyze the operational system? What is suitable for one set of objectives taught in a given environment may not be effective for the same objectives taught in a different environment that has different constraints placed upon it. For example, an excellent instructional system that is designed for teaching one child at a time may not be appropriate for teaching two or more simultaneously. The constraints of the system in which the designer expects to operate must be described. In analyzing the operational system, the designer must define:

Learners for whom the system is being designed (target group),

Number of personnel available to him on the project (man power),

Supporting equipment (machines),

Personnel scheduling, available curriculum material, description of course limits, and developmental time (procedures and materials),

Administrative limits, (management),

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[1] The thirteen steps are summarized in Figure 1.

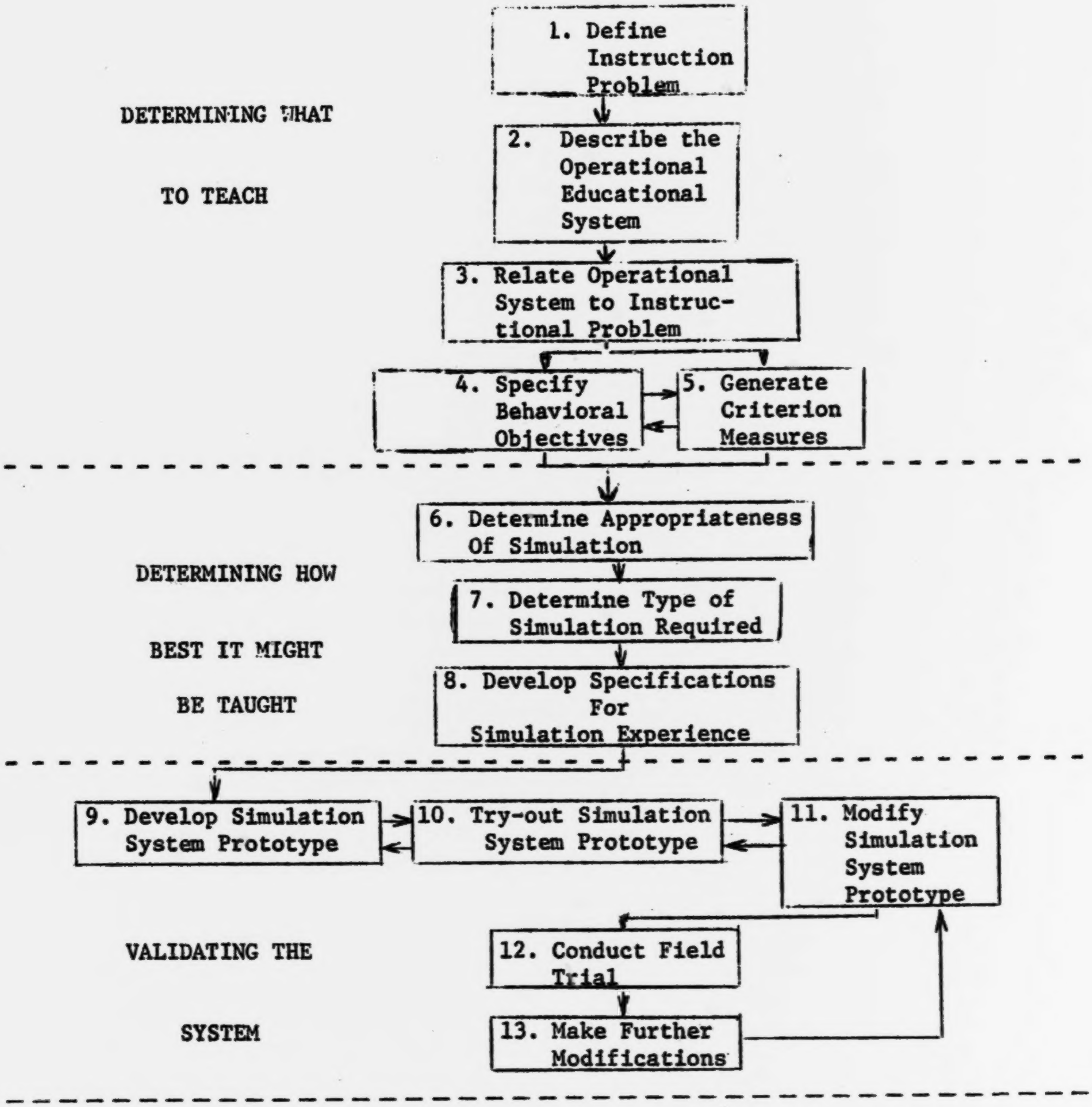
DETERMINING WHAT
TO TEACH
1. Define Instruction Problem
2. Describe the Operational Educational System
3. Relate Operational System to Instructional Problem
4. Specify Behavioral Objectives
5. Generate Criterion Measures
DETERMINING HOW
BEST IT MIGHT
BE TAUGHT
6. Determine Appropriateness Of Simulation
7. Determine Type of Simulation Required
8. Develop Specifications For Simulation Experience
9. Develop Simulation System Prototype
10. Try-out Simulation System Prototype
11. Modify Simulation System Prototype
VALIDATING THE
SYSTEM
12. Conduct Field Trial
13. Make Further Modifications

Figure 1.
Steps in the Design of an Instructional Simulation System

Facilities (setting),

Money available for the ongoing system and money available for developing the new system (funds),

Instructional philosophy or orientation that guides the system as well as the designer (educational orientation).

In summary, the designer should examine any element that he feels helps him to define the problem more clearly and to propose appropriate solutions.

Step 3. Relate the operational system to the problem

The inputs identified above must be related to each other. It makes little sense to think of an educational problem in isolation to the context in which it is found. This relating of the initially identified problem with the system may cause the designer to redefine or restructure the problem. In some cases the designer will face the choice of delimiting his interests and choosing certain aspects of the problems he has identified. This is based on the assumption that the more one knows about the system, the more problems will be perceived.

Step 4. Specify objectives in behavioral terms

There has been some confusion regarding the "hows" or specifying behavioral objectives, whether they be enabling or terminal. Enabling objectives state in precise terms the specific knowledge/skills the student must learn in order to arrive at the terminal performance. Terminal objectives state in precise terms the behavior that the learner is expected to exhibit after instruction. Where do objectives come from? Typically, the designer might begin by examining the unique key words, phrases, concepts, definitions, and rules that he frequently uses in the instructional unit. He looks at their natural sequence. That is, he analyzes a set of key concepts or definitions to see which are requisite for learning other key ideas. He constructs a hierarchy of principles that tell him in what order these principles should be taught. Basically, this analysis is used in the context of specifying what to teach, and requires the designer to choose some performance (that may or may not end up to be a terminal performance) and successively asking the following question: "What kind of capability would an individual have to possess if he were able to perform this objective successfully, were we to give him only instructions to do?"

Where else does the designer look for objectives? He may check his final exams he has been giving, and attempt to assess the degree to which they really tap the skills desired on the part of the student. He sees if there are more lifelike settings that could be developed that might more closely approximate the real skill that is being taught and tested. Perhaps a case study, filmed situation, or taped dialogue would be a better assessment tool. The designer actually generates specifications for some of these tests. Then he asks the question, "Does that behavior satisfy me that the knowledge/skills have been taught?" The designer infers knowledge from performance.

One other point should be emphasized. Educational objectives may be thought of as either stated (intentional), or unstated (unintentional). Stated objectives are those determined by the designer to be important and relevent to his problem. Unstated objectives are those which are not verbalized by the designer, but which may be just as appropriate as those stated. In designing instructional simulation experiences, where vivid experience is the keynote rather than reported experience, it is especially important that unstated objectives are considered. For example, extreme competition in a simulation game may produce the desired stated objectives, but at the risk of promoting dishonesty, thus not fulfilling an unstated objective regarding proper interpersonal behavior.

Step 5. Generate criterion measures

Simultaneous with determining behavioral objectives is the development of criterion measures. These take two forms: (1) terminal performance measures, and (2) enabling performance measures. The measures for assessing terminal performance determine whether or not the stated outcome behaviors were acquired by the learner as a result of the instructional experience. The measures for assessing enabling performance determine whether or not prerequisite behavior, necessary for adequate performance on the terminal objectives, have been acquired during instruction. Again, the designer should pay some attention to generating measurement insurements for unstated objectives.

Step 6. Determine appropriateness of simulation

Simulation has several advantages over more conventional forms of instruction, although cost may be more. Seven possibilities in which simulation may offer a useful and cost - justifiable alternative are:

1. Simulations are appropriate when objectives emphasize emotional or attitudinal outcomes;

2. Simulations integrate affective and cognitive behavior;

3. Simulations initiate sustained learner activity and motivation;

4. When the objective is to represent a social or man-machine system in such a way that the learner must interact with it, the system will react to the learner's moves, and the learner can discover the effects of alternative decisions, simulation is useful;

5. Simulation, in which a high degree of commitment may be introduced, is useful when emphasis is upon incorporation of the behavior desired within the personal domain of the learner;

6. Simulations provide an interest - sustaining mode that is particularly useful for exercising behavior, particularly under a variety of contexts;

7. Simulation is a most powerful means of placing a learner into a desired "set" or "perceptual frame" to sensitize and direct him.

On the other hand, there are some arguments against the use of simulation:

1. Simulation is not so efficient when it comes to the acquisition of cognitive knowledge as measured by typical tests;

2. Simulation may cost more than conventional types of instruction;

3. More information can be presented in less time by more traditional means of instruction;

4. Simulations, particularly the learning game variety, often introduce considerable changes in classroom noise level, physical movement, and teacher role that are highly suspect to some instructors;

5. Simulations are often difficult to evaluate because of the human processes that are modeled.

Step 7. Determine type of simulation required

If a decision has been reached to consider the use of simulation, the next set of decisions relate to the kind, or the attributes, of the simulation to be designed. The three major possibilities are: interpersonal-ascendent simulation, machine/media-ascendent simulation, and non-simulation games.

Interpersonal-ascendent simulation refers to the role playing and decision making, player-interacting simulations as typically found in such games as Consumer, Crisis, and Manchester. Interactions between learners carry a large share of the instructional burden.

Machine-or media-ascendent simulations are characterized by the instructional burden being carried largely by media (for example, slide-tapes, films, programed instruction, computer output, and so forth.) Examples include flight trainers, systems trainers such as weapons systems simulators used by the military for submarine crew training, computer-based business games and classroom simulation (Twelker, 1967; Cruickshank, et. al. 1967).

The third category of non -simulation games, is included, despite its non-sequiter label, largely because of the number of learning games that are being developed that do not simulate a model of reality. Such game includes the Nova game: Wff'n'Proof, On-sets, and Equations. These games certainly bring some of the advantages of simulation games to instruction, but do not simulate any social or physical system. Yet, they do provide involvement on the part of the learner in the application of concepts and principles drawn from formal disciplines.

Table 1 presents the advantages of each type of simulation technique. It should be noted that the advantages listed are relative advantages and do not preclude the possibility of one or another type of simulation being adequate in any given situation.

Step 8. Develop specifications for simulation experience

A common error that novice simulation designers make is to assume that the simulation exercise represents reality per se. They fail to realize that the simulation is not based on reality directly, but on a model or theory of reality. In other words, the model is a representation that is in some way removed from reality. It might be appropriate to say that a simulation will only be as good as the model on which it is based. The model is usually stated in general terms and includes many variables that may be deleted or altered in the simulation. Thus, the simulation is a representation of the model, but not an exact image. Changes have occurred. It behooves the simulation designer to construct or use the best fitting model he can so that he subsequently builds a fair chance of representing the relevent aspects of reality adequately. If the model is not a good representation of reality, that is, it distorts reality or omits relevant aspects of reality, and the simulation designer does not recognize this, the simulation has little chance of

Factor	Type of Technique Interpersonal Ascendent Simulation	Maching/Media Ascendent Simulation	Non-simulation Game
1. Control (reproducibility) desired	Questionable	Good	Difficult
2. Control (planned variation) desired	Questionable	Very Good	Good
3. Input must be machine mediated e.g., visual stimuli required	Not easily adopted	Appropriate	Not easily adopted
4. Psychomotor and perceptual learning involved	Questionable	Very Good	Questionable
5. Learners posses low entry skills & limited response repertories that prevent an inter-personal-ascendent simulation from functioning	Limited value	Useful	Questionable
6. Teacher control over class required	Not so good	Very good	Fair
7. Simple and inexpensive technique desired	Good	Not easily done	Very good
8. Interaction between learners required	Very good	Possible but costly	Good
9. Burden of simulation experience on learner required	Good	Possible	Possible
10. Model that emphasizes human interaction involved	Very good	Not easily done	Questionable
11. Individual differences must be considered but expensive to implement	Good	Not easily done	Good
12. Feedback must be easily designed into system	Good	Sometimes costly and difficult	Good
13. Feedback must come from peers	Good	Difficult	Good
14. Easy development process required	Sometimes difficult	Sometimes difficult	Very good
15. Insertion into curriculum must be easy	Sometimes difficult	Sometimes difficult	Very good
16. Must be generally acceptable	Sometimes difficult	Good	Very good
17. Few learners involved	Limited	Good	Very good
18. Learning objectives congruent or identical to standard course objectives	Limited	Good	Very good

Table 1 - Advantages of Each Type of Simulation

instructing learners in the appropriate behavior. The relationship between reality, the model, and the simulation are graphically presented in Figure 2.

Step 9. Develop simulation system prototype

At this point, a good share of the work of simulation system design has been accomplished, and the "fun" of building the system begins. The main task is that of translating instructional "blue prints" into prototype. The more complete and thought out the blueprints, the faster and easier the development.

Step 10. Tryout simulation system prototype

An empirical tryout of this system is mandatory. The tryout is limited in nature. If possible small groups of learners, or even one learner at a time if appropriate, are taken through the system by the designer. Close monitoring of the learners is undertaken. Analysis of the system is not limited to this. Learners may be requested to verbalize problems with the materials, and suggest alternate strategies. It should be noted that the limited tryout of a system such as a simulation game may look quite different than a tryout of the media-ascendent simulation. Video taping of simulation game prototypes is an extremely effective way to capture activity for later analysis with a select group of learners sitting with the designers. Sometimes, a simulation may be tried out on colleagues before using learners that represent the target group so that responsible criticism may be obtained.

Step 11. Modify the simulation system prototype

Three major decisions are made during this step: (1) If the system seems appropriate for obtaining the stated objectives, how can it be improved? (2) If the system does not seem to be appropriate for obtaining the stated objectives, how can it be changed? (3) If the system does not seem appropriate for obtaining the stated objectives, should it be discarded in favor of a non-simulation system?

Step 12. Conduct field trial

The field trial serves to aid the designer in determining if his newly developed system is capable of standing by itself, that is, being used in the field under operational conditions by members of target population. Designers often neglect this crucial step, reasoning that "since I was successful in using the system, everyone else can use it now". The safest thing a designer could do is subject his system to a trial under field conditions. When this is done, the designer may wish to collect data concerning the stated outcomes as well as the unstated outcomes. In some cases, the designer might consider securing the services of a third-part evaluation team to conduct the field trial.

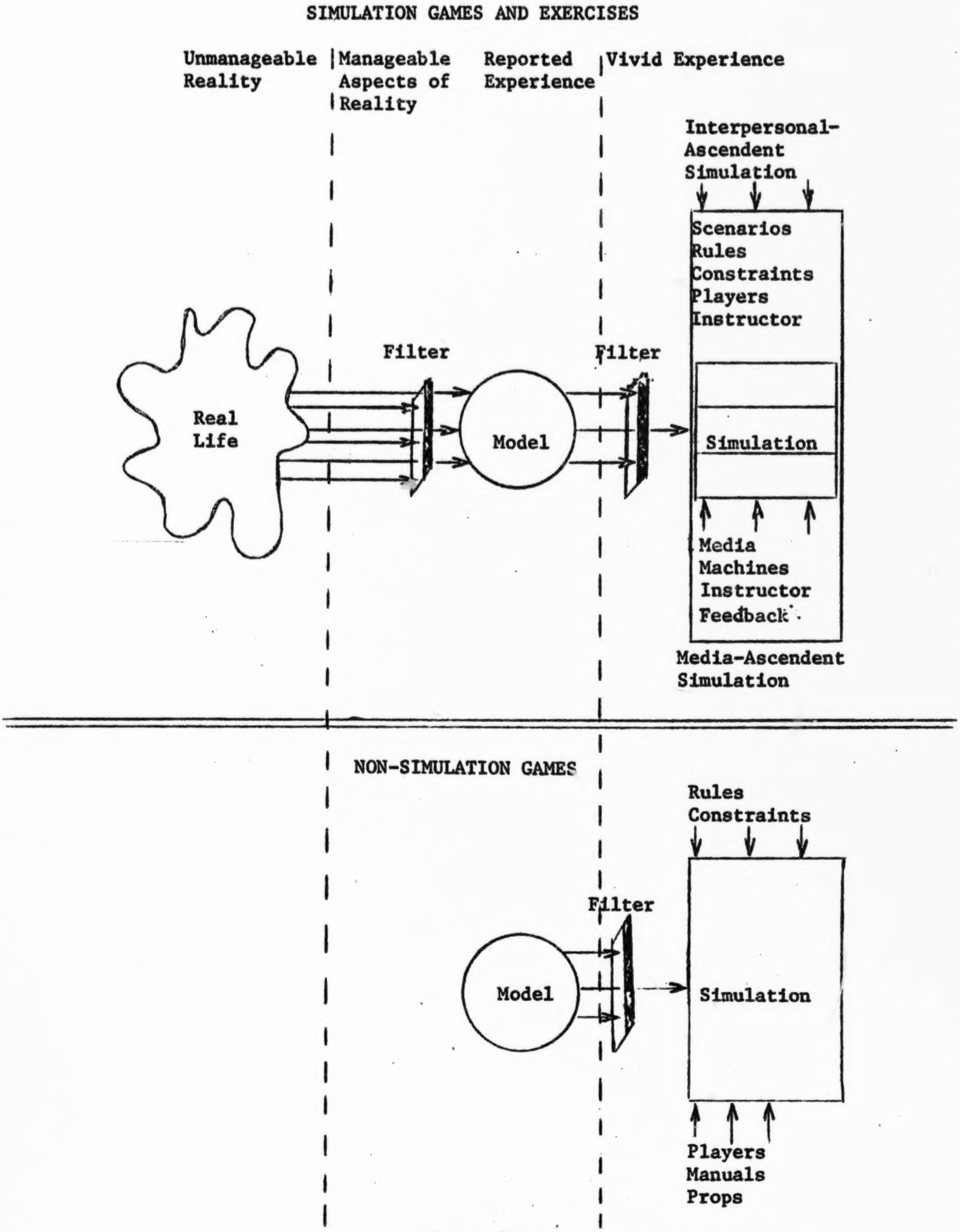
SIMULATION GAMES AND EXERCISES
Unmanageable Reality
Manageable Aspects of Reality
Reported Experience
Vivid Experience
Interpersonal-Ascendent Simulation
Scenarios
Rules
Constraints
Players
Instructor
Filter
Filter
Real Life
Model
Simulation
Media
Machines
Instructor
Feedback
Media-Ascendent Simulation
NON-SIMULATION GAMES
Rules
Constraints
Filter
Model
Simulation
Players
Manuals
Props

Figure 2.
Graphical relationship between reality, models, and simulations

Step 13. Make further modifications to the system deemed appropriate from field trial evidence

When this point is reached, it is hoped that few "bugs" are found in the system as detected during the field trial. If the previous steps have been executed in an excellent manner, the field trial will indicate improvement, not major changes. At this time, the designer may also begin investigating ways to disseminate his system.

A Final Word

Sarane Boocock and E. O. Schild state in their book on Simulation Games that "simulation design is not only a science, it is hardly a craft, but rather an 'art' in the sense that we have no explicit rules to transmit." (Boocock and Schild, 1968, p. 266) Others have made essentially the same statement of media-ascendent simulation. This position can not be argued. Further, the guidelines offered above certainly are one step in the right direction as meaningful research directions may be specified in the context of the development of simulation exercises.

WELL WORTH WAITING FOR . . .

The new bibliography on instructional simulation, that is. Type is being set, and galley proofs are being read regularly. We'll let you know about the procedure for ordering the document soon.

LANGUAGE LEARNING FUN?

The acquisition of effective communication skills is particularly difficult for the disadvantated child from a bilingual or foreign language background. Typical language development programs intended for the monolingual disadvantaged child tend to be highly teacher centered and controlled. These programs are characterized by tedious drill and are rarely directed toward the solution of problems perceived as relevant by the learner. A project headed by Dr. Jack Crawford and Mrs. Cathy Kielsmeier is currently investigating the effects of using learning games to develop English language in bilingual children. In the report below, Mrs. Kielsmeier outlines some of the goals and accomplishments of the project.

LANGUAGE AND THOUGHT GAMES FOR CULTURALLY DIFFERENT CHILDREN

The particular problem with which we have been working is to develop English language in bilingual children in the Pacific Northwest. We have found that the particular population with whom we are working exhibits not only poor proficiency in English but also in their own native tongue. Thus these children enter school with a double handicap.

Our present work has been with 4, 5 and 6 year old Mexican-American and Russian-American children. We have been developing and using materials for language learning which utilize game-like situations, rather than tedious drill. This "game" technique incorporates the components of frequent overt responses, repetition, and immediate feedback, found in many other methods presently being used to develop language. The more unique features of the approach, however, are aimed at incorporating pleasant affect into the situation by structuring the situations so that they stress a high, sustained level of motivation, self-directed activity, peer group socialization, and unobtrusive, non-punitive monitering by an older child or adult.

Results thus far indicate that the initial major objectives of rapid language acquisition and high sustained motivation have been effectively met. Within one month, many children are able to speak with simple sentences which are adequate for communicating their needs. It would seem that considerable latent learning may be involved when this approach is utilized, exhibited in the frequently observed phenomena of the sudden unexpected emergence of the complete sentence form of communication, where previously only single words had been used. The exact dynamics involved in this phenomenon might bear considerable investigation. It bears a striking similarity to the pattern of acquisition of speech in younger monolingual children.

Our goal has been to develop a technique which will yield long-term payoff to the child in terms of structuring the learning activities so that he will be able to:

1. view language as a pleasant activity
2. use language as a profitable tool to explore and control his environment; e.g. to satisfy his curiosity, make known his wants, to solve problems, and develop language-based conceptual hierarchies.
3. acquire a learning set and skills which will enable him to extend his language acquisition skills into his environment, outside of the specific learning situation.

Future activities are planned for the expansion of the present materials. Some of these are:

1. Teaching of English to additional bilingual populations other than Russian and Spanish.

2. Teaching of foreign languages to English speaking populations.
3. Extension upwards of the age ranges for the games to secondary schools and adults.
4. Extension of the materials beyond application to cognitive functions, to include the function of language in the expression of affect.

A SPECIAL NOTICE

This issue marks the last of four newsletters to be published in conjunction with the U. S. Office of Education - funded project, Instructional Simulation: A Research Development and Dissemination Activity (Project No. 7-I-045). The staff of the project has enjoyed this means of reporting its activity and findings to you these past 18 months.

Our readers responses to the newsletter have been overwhelming and prompts the staff of the Simulation Systems Program to continue the publication of the newsletter. We feel that it is important to open every channel of communication available, and to this end, we will continue to send at no charge subsequent issues of the newsletter. We ask only one favor of you in return. Take the time to complete and return the enclosed postal card. In this way, we'll know to keep your name on our mailing list. If we don't receive your card, we'll assume that you do not wish further copies of the newsletter.

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Appendix C

Suggested New Directions for Games and Simulations

Jack Crawford

1. As Diagnostic Instruments

Some use has been made of simulations as screening devices in professional education (Levine and McGuire, 1968; Mcguire, 1968; University of Illinois, 1967) and as part of a criterion test via the critical incident technique (cf., Frederiksen, 1962). However, their employment to measure aspects of personality has not been pursued.

Simulations offer powerful advantages as contrasted to the conventional testing instruments:

(a) Realistic problems can be presented with all the attributes that tend to give them impact. The usual verbal and pictorial instruments are necessarily abstracted with much of the affect-producing elements.

(b) The sequences of the subject's interactions and moves, a series of his perceptions, decisions, actions and subsequent perceptions of his own decisions and their consequences can be made visible. Furthermore, these observations can be sustained for lengthy periods as required or even replicated.

(c) The range of possible stimuli to be used can be definitely expanded. For the nonverbal or highly disturbed subject this may be a crucial aspect of diagnosis.

(d) The combination of simulation with modern audio-visual recording allows for obtaining direct and replicable responses. The disadvantages usually associated with examiner interpretation and coding can thus be minimized.

2. As a Therapy Technique

Many game-like processes have been incorporated into various approaches to therapy. Role-playing and the expressions of feelings have been the primary emphases. However, little effort has been given to the combination of such affect with rational decisions, examining consequences from those decisions, etc.; that is, the pattern used by a typical simulation game in which other aspects than pure feeling are emphasized. The advantages of the development of such a graded series of simulations in which the introduction of usually avoided feelings and decisions is gradually made to the client, offers an approach consonant with learning theory and one that may be practicable in terms of therapist time. It is quite feasible that the newer learning games may teach and therapy games may heal without the continuous intervention of skilled professionals.

3. For Measuring the Effects of Therapy

The treatment outcomes of psychological problems has been most recalcitrant to evaluation. The use of simulations to measure the degree to which people have changed under treatment presents new possibilities for the controlled introduction of those complex and realistic setting factors which have thus far clouded attempts to measure outcomes.

We might, for example, develop a series of pre- and post-tests that would incorporate various problem situations based on initial diagnostic information. The way in which clients interact in these game problems before and after treatment could be carefully analyzed. One advantage is that stressful and motivating conditions are readily and unobtrusively introduced into simulation exercises so the tendency for client responses to reflect socially desirable outcomes rather than his real way of handling the problem can be minimized.

4. For the Analysis of Interpersonal Transactions in Organizations and Institutions

Attempts to analyze the actual processes in any group and to distinguish these from intentions and recalled memories is difficult. Simulated institutional and group interaction can be closely tied to those essential variables involved, and offers an opportunity to encapsule and examine in clear detail the working behavior of people.

5. As a Test of Theories and Models of the Social Sciences

One of the advantages here is that it is relatively easy to place into simulation exercises a large number of the essential variables and to control to some degree their number, intensity, and interaction. Variables and interactions may be represented which were heretofore considered outside the realm of experimentation.

6. As an Aid to Theory Construction in the Social and Behavioral Sciences

The suggestion here is not only testing hypotheses, but to develop models which will suggest new variables and relationships. The simulation interaction offers a chance to insert new variables or principles not found in the observable real world. Furthermore, the outcomes may not readily be apparent but may reveal themselves through the behaviors brought out by the simulation. Unexpected outcomes of non-real (or apparently non-real) simulations offer a further source of theory building.

7. As a Setting for the Exploration of Variables

This use should be distinguished from that of testing a model. Here we are referring to a simulation as a framework which would allow the insertion of one or a set of variables. Within the simulation setting, intensity of a given variable may be changed or others inserted. For example, the use of simulations as a deliberate device to manipulate values, motives and feelings. The power of simulation games to do this has been noted previously but never explored.

8. Use of Target Populations Which Have Been Relatively Unamenable to Conventional Treatments

We are referring to groups with learning handicaps or from culturally different origins. Games and simulation exercises offer a chance to break loose from cultural constraints and open routes of communication other than the typical and unsuccessful verbal and symbolic communication ordinarily used.

9. Employment to Heal Intense Social Conflicts.

Many social problems are based on such intense disagreements about values, attitudes and perceptions of other's roles, but solutions are slow in attainment. The employment of simulation games offers a chance to get key participants involved and cognizant of the outlook and the problems of others in a deeper way than the mere cognitive identification or naming of the other person's views. The use of such games to first broaden understanding and then develop cooperative solutions may be a promising one for labor-management, student-administration, and black-white difficulties.

10. Use of Simulations, Not Simply to Cure Mental Illness or Heal Weaknesses, But to Promote Positive Growth and Health

Learning games offer a productive mix of cognitive and affective interactions for increasing human potential. Combinations of strategic problem-solving, artistic creation and the feelings of joy and ecstasy usually associated with the peaks of human achievement may be more readily accessible through a series of planned simulations. Simulations offer a chance to introduce the complexity required in a carefully graded series of learning encounters designed to promote rapid growth and learning, maximizing transfer.

11. Coupling of Simulation Games to Other Technological Advances.

The employment of games in conjunction with computer resources is well documented. Their employment in conjunction with television, audio-visual recording, programmed units, etc., or these in combination has scarcely begun.

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